WETLANDS ARE NOT WASTELANDS

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Wetlands are not wastelands report

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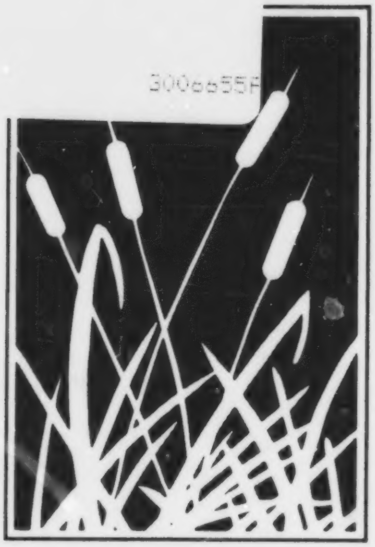

A JOINT PROJECT BETWEEN

WILDLIFE HABITAT
CANADA

Environment
Canada

WETLANDS ARE NOT WASTELANDS

PRAIRIE POTHOLE WETLANDS: FUNCTIONS AND EVALUATION

Prairie Region Pilot Study

November 1990

Report
7

Prepared for State of the Environment Reporting,
Canadian Wildlife Service, and
Wildlife Habitat Canada

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91-02037/

WETLANDS ARE NOT WASTELANDS PROJECT

LIST OF REPORTS

1. Wetland Evaluation: Methodology Development And Pilot Area Selection, Michal J. Bardecki, August 1987.
2. Wetlands Are Not Wastelands: Interim Report, Wayne K. Bond, Michal J. Bardecki, Kenneth W. Cox and Edward W. Manning, October 1988.
3. Application of Willingness-To-Pay, Opportunity Cost and Cumulative Impact Methods To Greenock Swamp, Ontario, Michal J. Bardecki, June 1988.
4. Application of Wetland Evaluation Methods To The Cowichan Estuary, British Columbia, Alan Ferguson, Gary Holman and Ron Kistritz, March 1989.
5. Application of Wetland Evaluation Methodologies To The Minudie Dykelands, Nova Scotia, Peter Stokoe, Jane Roots and Brad Walters, June 1989.
6. Wetlands Are Not Wastelands: Synthesis of Pilot Study Results, Michal J. Bardecki, December 1989.
7. Prairie Pothole Wetlands: Functions and Evaluation, Don A. Young and John P. Thompson, November 1990.

PREFACE

This pilot study is part of a multi-year project being led by the State of the Environment Reporting and the Canadian Wildlife Service (CWS) of Environment Canada, and Wildlife Habitat Canada, with the assistance of CWS Regional Offices. The overall goal of the project is to demonstrate that wetlands are not wastelands.

The objective of the project is to develop and pilot test evaluation methodologies in order to identify current or new approaches which best show and incorporate the sustainable resource values of wetlands. Based on these activities, a reference guide will be produced for use by provincial and local land-use planners in the evaluation of wetlands and wetland change proposals.

The Issue

Current methods of evaluating many resources portray inadequately their true environmental and economic value to society based on the functions they support. This is particularly true of wetlands, which, when threatened with conversion to other uses or with degradation, have been virtually impossible to value adequately using the most common current methods of evaluation. As a result, many good wetlands have been altered to other uses because their value to society cannot be demonstrated adequately and comparative evaluation methodologies automatically favour other short-term, high value uses of the land resource.

There is, however, an increasing body of scientific literature identifying the importance of wetlands functioning in their natural state in providing specific benefits to society. These functions include water storage, sediment retention and nutrient recycling, as well as the provision of increased biomass energy, biological diversity and fish and wildlife habitat. Likewise, there is a recognition of the value of these functions to society for wildlife and nature conservation, active and passive recreation, commercial plant and animal production, resource extraction, risk reduction, research and education, and aesthetics or landscape diversity, among others, by various governmental and other agencies. This recognition in turn has prompted the development of conservation-oriented initiatives.

The Project

In response, this project has focused on the development and testing of alternative procedures and evaluation methodologies which portray more adequately the true values of wetland resources. To do this, it is necessary to evaluate, adapt and develop methodologies, pilot test them on particular problems, and involve a wide spectrum of involved groups or individuals in the verification of the validity of such methodologies. The ultimate goal is to produce a reference guide backed by a broad consensus which can assist provincial and local land-use planners and decision-makers in the appropriate evaluation of wetlands when they are involved in a planning decision process. The major steps in the process are listed below and outlined in Report 2 (Bond et al., 1988):

a) Based on a workshop focusing on alternative methods of evaluating renewable resources (Manning and Cox, 1986), a short list of potential approaches to the evaluation of wetlands has been developed. These include:

    1. an approach based on willingness-to-pay for wetland values and functions;

    2. an opportunity cost approach to be applied to measurable resource values of the land and to the proposed alternate use; and,

3. a multiple function evaluation process for synthesizing a broader range of social goals and objectives than those generally encompassed by the term "economic".

b) The three alternative methodological approaches have been described in detail and the conceptual context of each is provided in the report "Wetland Evaluation: Methodology Development and Pilot Area Selection", Report 1, (Bardecki, 1987).

c) The three selected methods have been tested in four pilot studies across Canada - the current stage of the project. The four case studies are the Minudie Dykelands, Nova Scotia; the Greenock Swamp, Ontario; the Prairie Pothole region, Saskatchewan; and the Cowichan Estuary, British Columbia. These sites were chosen to allow for testing of the applicability of the methods using a variety of wetland types. The four pilot studies are now completed. This report provides the results of one of the pilot studies.

d) Based on the results of the case studies, a draft reference guide will be developed for application to the planning of the use of wetlands. It will include a discussion of the functions and values of wetlands, and the presentation of the range of approaches and methodologies appropriate to the evaluation of wetland values and their incorporation into the planning process. A workshop of experts has evaluated the pilot study results and advised on the purpose, format and contents of the reference guide.

e) The reference guide is to be drafted and field tested. A broad-based workshop of involved individuals from the planning community, wildlife community, agriculture, etc. then will be held to review, revise and provide support for the draft reference guide as an appropriate review process to be applied whenever wetlands use and management are in question. At a minimum, the reference guide should serve as a broad-based reference document for use by all decision-makers dealing with wetland conservation or conversion.

This Pilot Study

The Prairie Potholes Pilot Study represented a significant advance in the development of a wetland evaluation procedure for the Wetlands Are Not Wastelands project. Based on the results and assessment of the three previous pilot studies in this project, each of which employed three different evaluation methodologies, the prairie potholes study incorporated all three methods into one evaluation procedure. First, the "multiple function matrix" was used to screen for important wetland functions in each of the Study Areas. Second, the relative benefits and costs of developing and preserving wetlands were evaluated in terms of the "opportunity costs" associated with each development scenario. These opportunity costs were sometimes measured in terms of "willingness-to-pay" to maintain wetlands. Third, these benefits and costs were compared using a social benefit/cost analysis format to identify the optimal use of wetlands from a societal perspective. This three-phase approach proved to be practical and successful.

The multiple function evaluation process was of considerable assistance as a mechanism for screening the full range of wetland functions to determine which of these were relevant to the prairie pothole wetlands and warranted further research. The approach, however, could be advanced further in terms of citing relevant legislation, planning guidelines and standards that would help to indicate the value placed by society on wetland functions. The outlining of the best available indicators for each evaluation criteria and discussion of information gaps would also enhance the application of "the multiple function matrix" in future. The benefit/cost approach proved to be an adequate decision-making tool since an attempt was made to incorporate the full range of social benefits and costs derived from wetlands, rather than address only market-derived values. While the analysis was able to evaluate only a limited range of wetland functions, the results demonstrate sufficiently the importance of maintaining prairie pothole wetlands.

ACKNOWLEDGEMENTS

Overall, management of the project has been provided by a National Steering Committee comprised of Ken Cox, Wildlife Habitat Canada, Edward W. Manning and Wayne Bond, State of the Environment Reporting, Gerry Lee and Fern Filion, Canadian Wildlife Service. Funding for the pilot studies has been provided by Wildlife Habitat Canada, and State of the Environment Reporting, and the Canadian Wildlife Service of Environment Canada.

Scientific Authorities for the four pilot studies were:

- Minudie Dykelands: Joe Arbour, Canadian Wildlife Service, Atlantic Region
- Greenock Swamp: Edward W. Manning and Wayne Bond, State of the Environment Reporting
- Prairie Potholes: David M. Gierman, Canadian Wildlife Service, Western and Northern Region, and Wayne Bond, State of the Environment Reporting
- Cowichan Estuary: Ken Redpath, Canadian Wildlife Service, Pacific and Yukon Region

The authors of this report also wish to gratefully acknowledge the following individuals who contributed to the completion of this study.

- Dr. W.L. Adamowicz, Department of Rural Economy, University of Alberta, Edmonton (Member, Project Steering Committee)

- Kent Brace, Canadian Wildlife Service, Saskatoon (Member, Project Steering Committee)

- Dale Caswell, Canadian Wildlife Service, Winnipeg

- Doug Craig, Environment Canada, Saskatoon (Member, Project Steering Committee)

- Andrew Didiuk, Canadian Wildlife Service, Winnipeg

- George Hochbaum, Canadian Wildlife Service, Winnipeg

- Gordon Lewis, Inland Waters Directorate, Environment Canada, Regina (Member, Project Steering Committee)

- Ross Melinchuk, Saskatchewan Parks and Renewable Resources, Regina; Now with International Association of Fish and Wildlife Agencies, Washington, D.C. (Member, Project Steering Committee)

- Dan Nieman, Canadian Wildlife Service, Saskatoon

- Jack Smith, Canadian Wildlife Service, Saskatoon

The preparation and production of this report would not have been possible without the professional and technical expertise of various people who helped prepare and produce this report. These people include the following:

- Robert Scace, Scace & Associates Ltd., Calgary

- Rick Courtney, Environmental Management Associates, Regina

- Rita Dietterle, Environmental Management Associates, Regina

- Cindy Drobot, Drobot Data Services, Calgary
- Russ Eaton, Decision Research Inc., Regina
- Heather Ferguson, Environmental Management Associates, Regina
- Janice Hoover, Environmental Management Associates, Regina
- Daryl Johannesen, Environmental Management Associates, Regina
- Laura Morrison, Environmental Management Associates, Regina
- Bruce Pollard, Environmental Management Associates, Regina

EXECUTIVE SUMMARY

Historically, the pothole wetlands located in the southern half of the prairie provinces have been treated as wastelands. Drainage of wetlands has resulted as farmers seek to increase the area of land under production and to increase farming efficiency. These practices, combined with recent drought conditions, have resulted in the loss of 70 percent of wetland areas in the central prairies.

From a social perspective, recent studies have determined that wetlands in their natural state provide a broad range of benefits. These benefits include such things as flood protection, water purification, groundwater recharge, and wildlife habitat as well as providing a source of consumptive and non-consumptive recreational opportunities.

The purpose of this study was to further develop and test a wetlands evaluation procedure and to assess the optimal use of prairie pothole wetlands for two Study Areas in Saskatchewan using a variety of evaluation methods developed as part of similar investigations in other regions of Canada. These methods ultimately involved comparing the relative benefits and costs of developing or conserving wetlands from an economic perspective.

The Study Areas

Each of the two Study Areas consisted of a rural municipality in excess of 57,000 hectares in size. The Lost River Study Area is located 50 kilometres southeast of Saskatoon and wetlands were found to account for about 10 percent of the total land area. Nearly half of the wetland area (44 percent) is saline and only five percent consists of permanent wetlands. About 87 percent of the land area has been improved for agricultural purposes and much of the area has high agricultural capability ratings.

The King George Study Area is larger in area and is about 130 kilometres northwest of Regina. Only 70 percent of the land area has been improved for agriculture and soils are less productive. Wetland areas account for about seven percent of the total land area and 35 percent of these are saline. Permanent wetlands account for six percent of total wetland area.

Benefits of Wetland Drainage

From the perspective of a farmer or landowner, wetland drainage and cultivation typically provides a reasonable return on investment. Two forms of benefit result. First, the drained land can be cultivated and, for the lands in the study area, the net value of crop production on drained wetlands was found to be about $65 to $111 per hectare per year, depending on soil capability. Second, elimination of wetlands can lead to increased farming efficiency on adjacent lands, and these benefits were determined to typically range from $58 to $77 per hectare of wetland drained. Typical wetland drainage and land preparation costs were determined to be about $1,605 per hectare.

Using these costs, it was determined that additional drainage of wetlands on a typical 1.5-section farm in each of the Study Areas was not economical. Over a 30-year period, the annualized net losses ranged from $22 and $70 per hectare, assuming a discount rate of 10 percent (net of inflation). Yet, despite these calculations, survey results showed that, in the King George Study Area, additional wetland drainage is being considered on four percent of farms with remaining wetland areas. In the Lost River Study Area this proportion is even higher - 10 percent. This apparent inconsistency is partly a reflection of different soil capabilities but is also due to the effect of extensive farm input and price subsidies which have not been included in the analysis. According to a study recently commissioned by Wildlife Habitat Canada, Environment Canada and Agriculture

Canada, these subsidies could be as high as $106 per hectare for a Saskatchewan grain farm.

Benefits of Wetland Conservation

A review of potential wetland functions indicated that, for the two Study Areas, wetlands were most important in terms of groundwater recharge and soil moisture enhancement, waterfowl habitat, and as recreational resources. However, owing to lack of information, only the recreational aspects of wetland functions were quantified in economic terms.

Based on the results of a survey program, it was determined that about five percent of households in southern Saskatchewan visited the study area wetlands for recreational purposes. Total visitation amounted to about 110,900 user-days and the value of recreation was estimated to be $0.5 million based on willingness-to-pay for these recreational opportunities. From other data sources, it was determined that waterfowl hunting attributable to study area wetlands accounted for 3,100 hunter-days for Saskatchewan residents, with an associated value of $0.1 million. However, the corresponding hunting benefits accruing to U.S. hunters accounted for an additional $0.7 million. Overall, the recreational benefits of study area wetlands from a Saskatchewan perspective amounted to between $68 and $163 per hectare. However, due to the limitations of the valuation technique used and the observation that only certain forms of resident recreation were addressed, the benefits could have been at least twice as great. From a continental perspective, wherein the recreational benefits generated for U.S. waterfowl are included, the corresponding value of Study Area wetlands ranged from $156 and $249 per hectare.

Summary of Results

When the relative benefits and costs of wetland preservation and development for a typical 1.5-section farm in each of the Study Areas are compared, it is evident that from a societal perspective, conservation represents the optimal use of wetlands. For the farmer, however, wetland drainage and cultivation represent the best use of wetlands due to the effect of various farm subsidy and support programs.

On the other hand, in order to secure the upland areas surrounding wetlands or to increase the number of wetlands in the prairie pothole region, it is necessary for farmers to be compensated for the potential loss of revenues. Given the size of these potential revenues ($65 to $111 per hectare), it is evident that existing habitat retention programs based on annual long-term lease rates of $62 to $74 per hectare ($25 or $30 per acre) will only be partially successful, notably in areas with poorer agricultural capability.

Implications for the Wetlands Are Not Wastelands Programs

Unlike the previous pilot studies in this project, each of which employed three different evaluation methodologies, the prairie potholes study incorporated all three methods into one evaluation approach. First, the "multiple function matrix" was used to screen for important wetland functions in each of the Study Areas. Second, the relative benefits and costs of developing and preserving wetlands were evaluated in terms of the "opportunity costs" associated with each development scenario. These opportunity costs were sometimes measured in terms of "willingness-to-pay" to maintain wetlands. Third, these benefits and costs were compared using a social benefit/cost analysis format to identify the optimal use of wetlands from a social perspective. This three-phase approach proved to be practical and successful.

The multiple function assessment approach was of considerable assistance as a mechanism for screening the full range of wetland functions to determine which of these were relevant to the prairie pothole wetlands and warranted further research. The benefit/cost analysis approach proved to be an adequate decision-making tool for assessing environmental issues for the reason that the analyses attempted to incorporate the full range of social benefits and costs, rather than address only market-derived values. While the analysis was able to evaluate only a limited range of wetland functions, the results adequately demonstrate the importance of preserving prairie pothole wetlands.

Overall, it can be concluded that the combined use of the multiple function method and benefit/cost analysis provide a useful and consistent procedure for assessing a broad range of environmental issues, including wetland conservation. If adopted by planners and decision-makers, the pilot study methodology could lead to better-informed decisions about renewable resources like wetlands. The main limitations of this procedure remain a lack of information about the full range of wetland functions and reliable estimates of the benefits that wetlands can provide. More research related to both the nature and the societal value of wetland functions will have to be undertaken.

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1.0 INTRODUCTION

The Prairie Pothole Wetlands study represents a continuation of a multi-year project to demonstrate that wetlands are not wastelands. The study is being led by the Sustainable Development Branch, Canadian Wildlife Service (CWS) and Wildlife Habitat Canada, with support from Environment Canada regional offices. In the case of the Prairie Pothole Wetlands study, additional contributions were made by a technical steering committee representative from the Government of Saskatchewan, Department of Parks and Renewable Resources.

The overall objective of this wetlands study is to develop and test a process whereby the long term benefits of maintaining and protecting wetlands can be identified, evaluated and compared to the potential benefits of developing wetlands for alternative uses. By establishing the trade-offs between conservation and development, it is hoped that better-informed decisions regarding the optimal use of wetlands from economic, social and environmental perspectives will occur. Ultimately, the data and evaluation processes generated by this and other studies will be used to produce a manual that will allow landowners as well as local and provincial planners to better manage wetland resources.

In the past, failure to recognize the benefits from maintaining wetlands has led to substantial losses and degradation of wetlands resources in Canada over the last two centuries. According to a recent source:

> Since the turn of the 19th century, an estimated 20 million hectares (51 million acres) - one-seventh of Canada's total wetland base - have been drained or lost to other functions. Millions more hectares have been seriously degraded or are at imminent risk[1].

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[1] Environment Canada (1989a). Draft Federal Policy on Wetland Conservation and Highlights of Draft Implementation Plan: Discussion Paper, p 5.

For the prairie provinces, the loss of wetlands is even worse: seventy percent of the potholes in the central prairies have been lost[2], with the biggest factor being land development for agricultural purposes. For the period from 1981 to 1985, an average of 59 percent of wetland basins in Saskatchewan were altered on an annual basis[3]

While the potential benefits from draining wetlands to enable other types of land use are easily apparent and can readily be measured in economic terms, the functions and benefits of maintaining wetlands in their natural state have only recently been recognized and are difficult to measure. Wetland functions include water storage, groundwater recharge, water purification, sediment retention, flood protection and nutrient recycling as well as providing important wildlife habitat and maintaining biological diversity. For these and other reasons, the World Conservation Strategy has identified coastal and freshwater wetlands as the third most important life support system on the planet.

With the increasing recognition being given to the benefits of maintaining wetlands, resource managers are now faced with a dilemma: how can the benefits of wetland preservation be integrated into decision-making so that the best long-term use of these resources can be attained? On the one hand, we can measure the economic and financial benefits which may accrue to the landowner from alternative uses of wetlands, like agriculture. On the other hand, conservation of wetlands can provide benefits to society at large but these benefits are difficult to quantify in terms that can be readily incorporated into a typical decision-making process.

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[2] Ibid.

[3] Turner *et al.* (1987) also reported that 78 percent of wetland margins in Saskatchewan were also affected by agricultural activity during this same period.

The "Wetlands Are Not Wastelands" project represents an attempt to at least partially resolve this dilemma through the development and testing of methods for evaluating the social benefits of maintaining wetland resources. Evaluation theories and practices have been adapted from the realm of welfare economics and are now being tested through four field applications or pilot studies in different parts of the country. Three of these pilot studies have been completed and include the following:

Ontario Region:	Greenock Swamp, Ontario
Atlantic Region:	Minudie Dykelands, Nova Scotia
Pacific and Yukon Region:	Cowichan Estuary, British Columbia

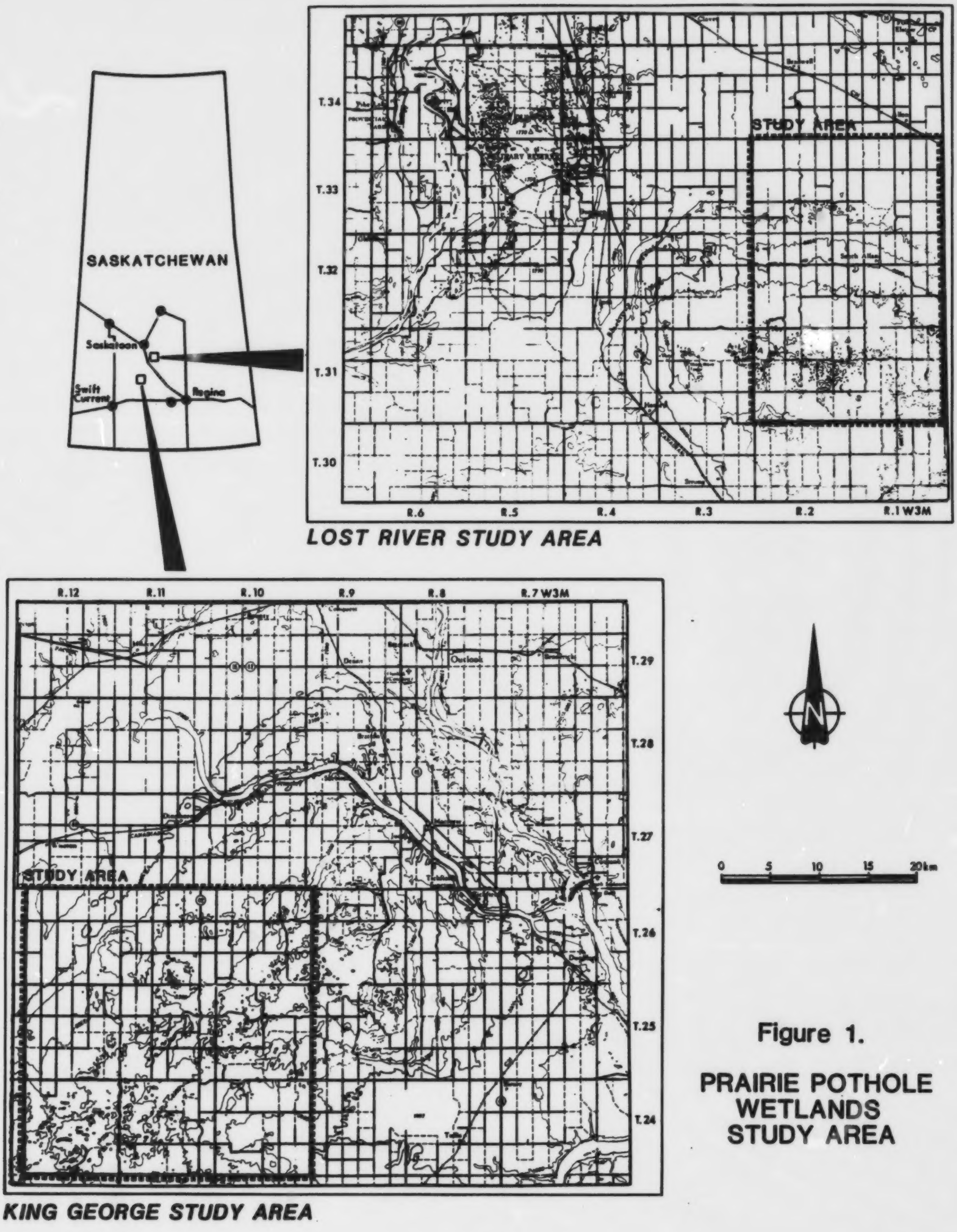
The fourth pilot study, for the Prairie Region, is the subject of this report.

This evaluation of prairie pothole wetlands differs from the previous three pilot studies for a number of reasons. First, by benefit of being last, much of the experience gained during the other three pilot studies has been applied to this pilot study. In this way, the strengths and weaknesses of each of the three different approaches: willingness-to-pay, opportunity cost and cumulative impact assessment, were identified and assessed, with the result that a slightly different methodology was adopted.

Second, a workshop involving researchers from the other pilot studies and various resource specialists was convened in Ottawa in January, 1990, to evaluate the results of the previous three pilot studies and to undertake a critical assessment of the evaluation methods that were used. This workshop also established the outline of an evaluation procedure that could be employed in the field; the work program for this study was amended to demonstrate how this procedure would work.

A third difference is that the size of the area investigated as part of the prairie pothole wetlands study is significantly larger than for any of the other three pilot studies. Two separate areas in the prairie pothole region were selected for study and, as shown in Figure 1, they consist of multiple townships with a combined size of more than 141 000 hectares (ha). Similarly, the other pilot studies examined large, easily-defined, well-known wetland areas on public lands whereas the prairie pothole wetlands are typically found on private land and consist of numerous small and indistinct wetland areas. As a consequence, potential drainage of wetlands for other types of land use is not a yes/no decision but, rather, raises questions of quantity (how much wetland area might be affected) and quality (does it make sense to drain lower capability wetlands rather than higher capability wetlands). Given the range of evaluation issues related to the prairie potholes, further modification of the evaluation procedures used in the previous pilot studies was required.

The results of the prairie pothole wetlands study are provided in the remainder of this report. Section 2.0 contains an overview of the general methods and approaches used in the study. Section 3.0 provides a description of the two Study Areas, provides an inventory of wetland types in these areas and identifies wetland functions of significance in these areas. Section 4.0 undertakes an analysis of the benefits derived from the significant wetland functions in the two Study Areas while Section 5.0 describes the potential agricultural benefits that could be derived from drainage of wetlands in these areas. In Section 6.0, the respective benefits and costs of maintaining and developing wetlands are compared to identify the optimal use of prairie pothole wetlands in the two Study Areas. A summary of study findings is included as Section 7.0.


SASKATCHEWAN
Saskatoon
Swift Current
Regina
T.34
T.33
T.32
T.31
T.30
STUDY AREA
R.6
R.5
R.4
R.3
R.2
R.1 W3M
LOST RIVER STUDY AREA
R.12
R.11
R.10
R.9
R.8
R.7 W3M
Outlook
T.29
T.28
T.27
T.26
T.25
T.24
STUDY AREA
KING GEORGE STUDY AREA
N
0
5
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15
20km

Figure 1.

PRAIRIE POTHOLE WETLANDS STUDY AREA

2.0 APPROACH AND METHODOLOGY

The approach for this project was comprised of three major tasks. The initial task was to adopt a system for classifying wetlands in the Study Areas according to type and capability. The second task was to identify which of the various wetland functions are important and/or significant in these areas. The third task involved the development and implementation of a procedure for measuring the benefits derived from these wetland functions. A description of the methods used to complete each of these tasks is provided below.

2.1 CLASSIFICATION AND INVENTORY OF WETLANDS

A wide variety of wetland classification schemes are available for describing prairie wetlands[4]. While each of these classifications have their own merits, the Stewart and Kantrud (1971) scheme, with some modifications from Cowardin *et al.* (1979), was ultimately selected for a variety of reasons:

- it was specifically developed for classifying wetlands in a glaciated prairie environment, such as that represented by the two prairie pothole wetland areas selected for study;

- the results of this wetland classification system can be used as input for the wildlife habitat evaluation models which were used to evaluate biological productivity; and,

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[4] Examples of these are identified in Stewart and Kantrud, 1971; Millar, 1976; Cowardin *et al.*, 1979; and Adams 1988.

- the wetland types could be identified by remote sensing without need for extensive ground-truthing[5].

Classification of study area wetlands was then accomplished with the aid of 1:56 000 stereoscopic, black and white air photography. Using these air photos for reference, individual polygons of wetland and upland were then delineated on 1:20 000 photomaps.

In choosing the appropriate vintage of air photography to be used, it was decided, in conjunction with the Steering Committee, that wetlands should be inventoried under what would be considered "average" conditions. This assumption ruled out recent air photos, which would reflect recent drought conditions such that many wetlands would be dry or may have been altered in appearance (through agricultural use). The Steering Committee felt that photography from the late 1970's would be appropriate, as these years typified "average" conditions and, fortuitously, 1979 air photos were available.

The scale of these 1979 air photos coupled with the timing of the photography (summer) meant that small, ephemeral wetlands could not be distinguished and that temporary and seasonal wetlands could not be differentiated. As a result, the wetland classification scheme had to be altered somewhat, resulting in the following definitions of wetland types:

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[5] Given the size of the study areas (15 townships) and the timing of the study (fall and winter), a methodology which required ground-truthing would not have been feasible.

Temporary/Seasonal:

- incorporates both temporary and seasonal wetlands. Temporary wetlands include those where water is present only for a few weeks in spring and where some emergent vegetation occurs. Seasonal wetlands contain water throughout the spring and into summer, and emergent vegetation is more robust.

Semi-permanent:

- water is present throughout the year during most years. The wetland contains both emergent vegetation and open water zones. Submerged or floating vegetation is located throughout the open water zone.

Permanent:

- water is present except during prolonged drought conditions. Water levels are relatively stable as evinced by a well-defined open water zone. An emergent vegetation zone is present, but the deep portions of the open water zone are devoid of emergent and submerged vegetation.

Saline Intermittent

- highly-saline shallow water of a seasonal nature. Frequently devoid of vegetation.

Use of this approach resulted in an underestimate of total wetland areas (due to lack of ephemeral wetlands) and a stronger representation of permanent wetlands during the mapping process.

Upland area mapping was restricted to two categories: agricultural lands and pasture lands. In order to be consistent with the wetland classification system (described in Section 3.2), habitats other than pasture lands had to be recognized[6]. As a result, roadside ditches, which consisted of five metres on each side of roads, and wetland grass fringes (7.5 percent of the estimated surface area of wetlands[7]) were also mapped.

For final analysis, the wetland and upland polygons were digitized into an ARC-Info Geographic Information System (G.I.S.) from the 1:20 000 photomaps. This provided output not only in terms of maps (see appendices II and III) but also tabular summaries of wetland and upland types, surface areas and shoreline lengths. The representative maps were originally produced in colour to assist with delineation of different wetland types within a landscape containing a high density of wetlands. For the purposes of final report production, they have been produced in black and white. While this medium does not provide as much definition as colour, the density of wetlands is still effectively illustrated.

2.2 IDENTIFICATION OF WETLAND FUNCTIONS

To establish relevant wetland functions for the Study Areas, available information about the geological, environmental, and socio-economic characteristics of each area were compared to lists of wetland functions, as provided in a variety of data sources. These sources included the other pilot studies for the Wetlands Are Not Wastelands project, Environment Canada (1989), and the draft Alberta policy on wetlands management (Alberta Water Resources Commission, 1990).

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[6] As Blue-winged Teal prefer nesting in tall grasses, habitat types containing tall grasses were also delineated to assess potential nesting habitat.

[7] This conservative estimate was derived from field observations coupled with calculations derived from digitizing all the represented wetland types in the two Study Areas.

A synthesis of more comprehensive reviews of this topic by various authors (e.g. Greeson *et al.*, 1978; Shay, 1981; Cowan, 1981a,b; 1982; Brace and Pepper, 1984; Usher and Scarth, 1988) is contained in a recently-published document on Prairie Canada wetland functions (Young, 1989). Three major categories of wetland functions were identified in that report and examples of benefits arising from these functions can be identified as follows:

1. Role in hydrological and biogeochemical cycles:

- wetlands collect runoff, store it, provide natural flood control, recharge groundwater, and discharge water into receiving waterbodies such as streams and lakes;
- wetlands are the interface between aquatic and terrestrial ecosystems;
- wetlands reduce the erosive effects of floods by storing water and silt, and moderating salinity; and,
- wetlands purify water by removing agricultural chemicals, nitrogen and phosphorous resulting from runoff from agricultural fields, sewage (human and livestock-related) and sediments through a combination of processes including filtration, absorption by vegetation, sedimentation and decomposition.
- wetlands may play an important role in hydrological cycling in terms of evaporation and contribution to rainfall events.

2. Role in biological and habitat diversity:

- wetlands provide habitat for a broad variety of plants and animals, and are highly productive, supporting complex food webs. "Habitat" provides the life requisites of food, cover, breeding areas, water, space and other requirements for a species' survival; species are the products of their habitats (United States Fish and Wildlife Service, 1980). Wetland biotic diversity and density are typically higher than those of surrounding uplands[8];

- Wetlands and their associated wildlife, fisheries and vegetation (e.g., hay, wild rice) resources generate substantial benefits through harvesting and/or recreational usage; and,

- wetlands harbour "endangered" species such as the Piping Plover (COSEWIC, 1988). Wetlands provide important habitat for one-third of the rare, threatened and endangered species in Canada (Turner *et al.*, 1987).

3. Scientific and cultural value:

- wetlands provide laboratories for research and education[9];

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[8] For example, Cowan (1981a) listed approximately 45 waterfowl species, 115 other bird species plus a minimum of 50 furbearing and game species such as muskrat, beaver, Ring-necked Pheasants and white-tailed deer that were dependent on wetlands for all or part of their habitat requirements.

[9] For example, the Delta Waterfowl and Wetlands Research Station is undertaking ongoing studies which are contributing to the better understanding of ecological processes and are providing applied techniques for resource management.

- wetlands are aesthetically pleasing, providing substance and variation to the landscape, and thereby contributing to the quality of life; and,

- wetlands have several other intangible values such as existence value (just knowing that the entity and its associated values exist even without experiencing them), option values (future opportunity for as yet unappreciated values) and bequest value (values to future generations).

To facilitate identification of pertinent wetland functions for the prairie potholes study, a checklist was devised. This checklist was patterned after the "Cumulative Assessment Matrix" developed by the "Wetlands are not Wastelands" project team (Bond *et al.* 1988) and used to evaluate the Minudie Dykelands in Nova Scotia (Stokoe *et al.* 1989), and is presented as Table 1. However, unlike previous checklists or matrices, no indicators or rating schemes have been specified so as not to preclude any function or issue for which there may be no information. By addressing each of the screening questions on this checklist, the most significant of the various functions for wetlands in each of the Study Areas could then be identified for further study and evaluation.

2.3 EVALUATION OF WETLAND FUNCTIONS

Having identified which functions are characteristic of the wetlands being studied, the third task in the study approach was to quantify the importance or significance of these functions and evaluate their role in economic terms where possible.

As described above, wetlands have numerous functions, some of which (e.g., wildlife habitat) lend themselves to quantification and valuation easier than others (e.g., aesthetics). Unlike the Cowichan Estuary wetlands evaluation study (Ferguson *et al.*, 1989), where evaluation of wetland habitat was facilitated by good information on biological processes and recreational utilization, the Prairie Pothole Study Areas

TABLE 1

SCREENING QUESTIONNAIRE FOR IDENTIFICATION OF SIGNIFICANT WETLAND FUNCTIONS

Function	Evaluation Criteria		Rating/Comments
Hydrological Functions:	1.	Does the wetland contribute to recharge of aquifers?	
	2.	Does the wetland provide any flood protection benefits	
	3.	Will a change to the wetland enhance or reduce water discharge or recharge of groundwater	
	4.	Does the wetland provide a natural water purification process?	
	5.	Does the wetland(s) contribute to hydrological cycling (i.e. rainfall)?	
Habitat Functions:	1.	Are there any rare, threatened or endangered species present?	
	2.	Does the wetland provide protection of natural shorelines?	
	3.	Does the wetland contain high quality habitats for waterfowl?	
	4.	Does the wetland contain high quality habitats for other species?	
Ecological Functions:	1.	Is the wetland important ecologically in terms of functions such as ecological diversity, oxygen generation and nutrient recycling?	
	2.	Does the wetland support an extensive ecosystem complex including uplands?	
	3.	Has a threshold been reached where the integrity of wetland ecosystems will be compromised by further degradation?	

Function	Evaluation Criteria	Rating/Comments
Socio-Economic Functions:	1. Is the wetland used for commercial hunting, trapping and fishing?	
	2. Does the wetland provide opportunities for non-commercial use of fish, wildlife and/or water resources?	
	3. Does the wetland represent an important local, regional or provincial tourism or recreation attraction?	
	4. Is the wetland part of the pattern of settlement and rural lifestyles?	
	5. Is the wetland used as a commercial source of peat?	
	6. Are there other commercial uses of wetlands, such as harvesting opportunities for wild rice or cranberries?	
	7. Can the forest resources in the wetland be harvested?	
	8. Is the wetland(s) a unique national or regional resource?	
	9. Are there national or regional policies/programs to support conservation/restoration of wetlands?	
Agriculture Functions:	1. Is the wetland used as a source of forage?	
	2. Does the wetland serve to reduce topsoil erosion?	
	3. Does the wetland serve to improve soil moisture?	
	4. Is the wetland used as a source of on-farm water supply	
Educational Functions:	1. Is the wetland used for scientific research?	
	2. Is the wetland used for educational purposes?	

have not been examined in terms of wetland biological productivity, with the exception of some waterfowl surveys. Furthermore, the landscape of the Study Areas, with widely-scattered, small wetlands is not conducive to traditional recreational activities. Lastly, the wetlands are isolated, unconnected basins with the result that their function, in terms of water quality enhancement is not an issue with regard to receiving watercourses.

Given the lack of reliable information pertaining to most wetland functions, the wetland evaluation process for the Prairie Pothole Study Area has focused primarily on biological productivity. The measurement of habitat, in terms of its capability to support wildlife on the long term (essentially the concept of "carrying capacity"), is receiving widespread attention for baseline biological evaluations and impact assessments. The rationale for this approach is that numbers of species and individuals often may change for unpredictable reasons (e.g. fluctuations in numbers), but habitat potential (i.e. physical characteristics of vegetation and landforms, and their capability to provide food, cover, and other requirements) remains relatively unchanged in the long term.

Population-based or habitat-based data bases can each be used to assess biological productivity or capability. The habitat assessment approach relies primarily on the quantification of broad habitat types, and a knowledge of species/habitat relationships. Some data on species abundance and distribution are required, but only as a means of determining the habitat preferences of the study species. In general, accurate habitat data are less expensive to obtain than accurate population data, and are not highly time-specific.

A habitat-based approach to evaluating wetland wildlife habitat productivity was used for the Prairie Pothole Wetlands study. The actual methodology used is known as Habitat Evaluation Procedures (HEP). HEP was developed by U.S. Fish and Wildlife Service, as a standardized method of quantifying wildlife and fisheries habitat for use in impact assessments of proposed water and land resource development projects (United States Fish and Wildlife Service, 1980).

For use in evaluating wetland habitat in the two Study Areas, two indicator species were chosen to characterize the wildlife and habitats of the Study Areas. Based on the criteria of socioeconomic and ecological significance within the context of the Prairie Pothole Wetland Project, the two species selected were:

- Blue-winged Teal is representative of dabbling ducks which utilize a complex of wetland types and dense upland ground cover (also represents shorebirds and other species using seasonal and semi-permanent wetlands).

- Canvasback is representative of diving duck species which frequent semi-permanent and permanent wetlands with aquatic and emergent vegetation (also represents species such as Yellow-headed Blackbird).

The habitat requirements and preferences for these species have largely been determined through previous studies (U.S. Fish and Wildlife Habitat Evaluation Procedure published models which are relevant for the Study Areas in question: Schroeder, 1984; Sousa, 1985). Running these models with the remote sensing and field-generated biophysical facts provided a relative ranking of the wetlands and Study Areas both on an individual species basis and collectively in terms of the suitability of the area to support all of the indicator species. A description of current habitat quality, as measured by Habitat Units (HU's), formed the basis for describing baseline conditions against which the implications of future development were measured.

The Mallard represents a duck species toward which considerable effort will be directed as part of the North American Waterfowl Management Plan (NAWMP). While the use of this species for habitat modelling would have been valuable, the only published habitat assessment model for the Mallard required an expenditure of effort that was much too substantial for this study. As a result, the Mallard was eliminated as a dabbling duck model option and the Blue-winged Teal was selected.

While the biological component of the research focused on one particular wetland function (habitat), the assessment and quantification of wetland values also focused on a limited range of wetland functions related to habitat. Based on a review of the three previous wetland studies, it became evident that only certain types of wetland functions have been successfully evaluated in economic terms with any reliability, given current techniques and our understanding of wetland functions. These functions consist almost entirely of recreational benefits related to wetlands in the Study Areas.

For wetlands in other parts of North America there have been some recent attempts to quantify wetland values (Charbonneau and Hay, 1978; Jaworski and Raphael, 1978; Farber and Costanza, 1987; Manning *et al.*, 1988; Ferguson *et al.*, 1989). Approaches have varied from calculating estimated non-market benefits derived from activities such as bird watching and hunting/fishing, to estimation of replacement costs for ecosystem or specific functions (ie. water treatment). However, given the relative lack of information related to wetland functions in the two Study Areas, it was decided to focus research on recreational functions which could be assessed more easily than other, equally-important functions for which no site-specific information could be found.

The economic evaluation procedure employed a household survey that was designed to collect information about household use of wetlands in general and wetlands in the Study Areas in particular (see Appendix I). Questions about the value of wetlands for recreation were also incorporated into the survey and employed a contingent valuation procedure to measure the amount people would be willing to pay for wetland recreation opportunities. By relating data on levels of use and measures of value, the potential recreational benefits contributed by wetlands in the two Study Areas was estimated.

A second aspect of the evaluation process was to assess the potential benefits that could be derived from using wetlands for other purposes, in this case, agricultural use. To assess the net contribution of wetlands, the value of agricultural opportunities foregone by wetland conservation (opportunity costs) must be compared to the various benefits derived from maintaining wetlands in their natural state. Information on the agricultural use of wetlands was also derived through the household survey, with additional information on crop yields, value and production costs being obtained from other sources.

The net result of this evaluation process represents a crude benefit/cost analysis that considers the question of what represents the most effective use of wetlands from the perspective of economic efficiency. Given the size and nature of the pothole wetlands in the Study Areas, this question could not be resolved for the two Study Areas in total. Rather, a generic benefit/cost analysis was performed using average conditions for farmsteads in each of the Study Areas so the trade-offs between wetland conservation or conversion to agricultural use could be demonstrated. Such an approach cannot identify the relative benefits and costs for any specific wetland resources within the two Study Areas, but establishes an evaluation model which could be employed were sufficient site-specific data are available.

Lastly, a review was undertaken of the relevant legislation, planning guidelines, standards and government programs to evaluate how society valued wetlands.

3.0 THE PRAIRIE POTHOLE REGION

To provide a geographical context in which to develop and test a methodology for evaluating wetlands in the prairie region, two Study Areas containing pothole-type wetlands were selected. These areas were selected for two reasons. First, they are fairly typical of wetlands in the prairie/parkland transition area, especially in terms of intensified agricultural demands. Second, they are both located fairly close to population centres and have a high probability of utilization that can be readily documented.

3.1 DESCRIPTION OF STUDY AREAS

Two wetland areas in south-central Saskatchewan were selected for the prairie pothole wetlands study. These areas are comprised of the rural municipalities of Lost River and King George which are located in the Allen Hills and Missouri Coteau, respectively. These larger areas are renowned for their densities of wetlands and breeding ducks and are located within areas targeted as priority zones for implementation of the North American Waterfowl Management Plan (NAWMP; CWS *et al.* 1988). This is a multi-mullion dollar ($500 million in Saskatchewan alone), 15-year program with the objective of restoring and managing waterfowl habitat such that duck numbers can be restored to levels experienced in the early 1970's. The fact that NAWMP and other programs are devoting major resources to wetland conservation is yet another tangible indication of society's view that wetlands are a valuable resource.

The climate in the general vicinity of the Study Areas is classified as semi-arid continental. Precipitation is low, averaging 360 mm annually. Approximately half this precipitation occurs as rainfall during the June/July growing season. The moisture deficit ranges from 18 to 23 cm, with moisture efficiency slightly better in the more northern Lost River area. High annual and diurnal temperature ranges are experienced, with characteristically warm summers and cold winters. The mean annual temperature is about 3^0C, with mean daily temperatures ranging from -18^0C to -20^0C in January.

A sequence of Laurentide (Continental) glacial events have influenced the physiography of the Study Areas through superficial modifications to the pre-glacial landscape. Post-glacial erosion and deposition processes have further modified the landscape. In the Study Areas, the last glacial advance occurred some 12 500 years ago. As glacial ice retreated, a blanket of glacial till was left across the landscape, ranging in thickness from 0 to almost 200 mm (Hart and Hunt, 1981).

3.1.1 Rural Municipality of Lost River (R.M. 313)

The Lost River Study Area lies wholly within the Saskatchewan Plain or Second Prairie Steppe physiographic region (Bostock, 1967). Specifically, it is situated within the Allan Hills Upland physiographic subdivision which, at elevations of 580 to 670 m a.s.l., rise above the adjacent Saskatchewan River and Assiniboine River plains (Acton *et al.*, 1960). As shown in Figure 1, this study area lies approximately 50 kilometres southeast of Saskatoon.

The landscape of the Lost River Study Area is characterized by undulating to rolling till and lacustrine plains which reflect its glacial history (Hart and Hunt, 1981). The morainal deposits which predominate the landscape typically comprise undulating plains and high-relief knob and kettle terrain. They consist of variably textured, unsorted glacial till which have occasionally been reworked by post-glacial and recent mass wasting events. Within this morainal landscape, a sequence of low and high relief near level lacustrine plains reflect the presence of a variety of glacial lake developments. These deposits consist of fine-textured silts and clay and may be especially prone to erosion during prolonged dry periods. The northern extent of the study area is characterized by undulating glaciofluvial lacustrine deposits which have a high sand component and are easily eroded.

Soil development typically consists of Dark Brown Chernozems within the Lost River Study Area, although gleyed and regosolic soils are often found occupying wetland depressions in the knob and kettle terrain.

Although grazing and agricultural pressures have strongly modified local vegetation communities, the native vegetation of the study area is classified as Mixed Grass Prairie (Coupland and Rowe, 1969). Within this setting, a mosaic of spear grass (*Stipa comata*), June grass (*Koeleria cristata*), blue grama grass (*Bouteloua gracilis*) and a variety of wheat grasses (*Agropyron* spp.) predominate the uplands while grasses such as hair grass (*Agrostis scabra*), reed grasses (*Calamagrostis* spp.), sedges (*Carex* spp.), cattail (*Typha latifolia*) and bulrushes (*Scirpus* spp.) occupy the wet meadow, shallow marsh and emergent deep marsh zones of localized depressions. Wild barley (*Hordeum jubatum*) occurs typically around saline areas while buckbrush (*Symphoricarpos occidentalis*), silverberry (*Elaeagnus commutata*), and rose (*Rosa* spp.) occupy moister soils. Many waterbodies are ringed by aspen (*Populus tremuloides*) and willow (*Salix* spp.).

According to Table 2, which summarizes agricultural practices in the Lost River area, about 87 percent of the total land area (57 072 hectares or 141 030 acres) is farmer owned or leased. Of these farmlands, 87 percent of the land area is considered improved and 13 percent is unimproved. Improved land includes cropped area (52 percent of farmlands), summerfallow (33 percent), and pasture (two percent). Spring wheat is the dominant crop, accounting for 71 percent of cropped land. Durum wheat, barley and mustard are the only other crops with a significant acreage under production.

TABLE 2

NUMBER OF FARMS AND AGRICULTURAL LAND USE PATTERNS, LOST RIVER AND KING GEORGE RURAL MUNICIPALITIES, 1986

	Lost River				King George			
	No.	Ha	Acres	Pct.	No.	Ha	Acres	Pct.
TOTAL FARMS	136	49 832	123 136	100.	117	69 963	172 879	100.
Unimproved Area	96	6 468	15 982	13.0	72	22 214	54 894	31.7
Improved Area	135	43 364	107 154	87.0	116	47 749	117 985	68.3
Cropped Area	134	25 880	63 950	51.9	113	26 038	64 339	37.2
Winter Wheat	7	233	575	0.5	11	724	1 788	1.0
Spring Wheat	129	18 455	45 603	37.0	109	16 862	41 666	24.1
Durum Wheat	30	1 859	4 594	3.7	49	n.a.	n.a.	n.a.
Oats	12	210	520	0.4	20	283	699	0.4
Barley	52	2 750	6 796	5.5	47	2 221	5 488	3.2
Rye	6	219	540	0.4	2	n.a.	n.a.	n.a.
Flax	8	180	445	0.4	4	117	290	0.2
Canola	13	504	1 245	1.0	5	194	480	0.3
Mustard	5	1 470	3 632	3.0	9	357	881	0.5
Summerfallow	122	16 229	40 102	32.6	111	20 667	51 069	29.5
Pasture	18	1 029	2 542	2.1	13	841	2 079	1.2
Other Improved	44	227	560	0.4	33	202	498	0.3

Source: Saskatchewan Agriculture.
n.a.: not available

Information on agricultural practices on wetlands in the R.M. has been provided by the District Agricultural Representative. Within the northern two-thirds of the R.M., there are no cattle producers; there are six to eight such producers in the southern third. Wetlands in the northern portion of the Lost River study area have not been exposed to much agricultural - related disturbance in recent years. The rough topography makes new, additional drainage impractical and because the myriad of small wetlands usually contain water when seeding occurs, farmers are usually not able to till these wetlands during most years. As a result, these small wetlands have also become ringed with tall willows, with the result that it is difficult to manoeuvre haying equipment inside wetlands that are usually less than 0.5 ha in size. In the northern part of the R.M. less than five percent of the dry wetlands are currently hayed or planted while, in the southern half, this percentage increases to about 50 to 60 percent. Wetlands in close proximity to roads are more prone to being used for agricultural purposes.

3.1.2 Rural Municipality of King George (R.M. 256)

The King George Study Area is divided by two distinct physiographic regions, the Alberta Plain, or Third Prairie Steppe to the southwest, and the Saskatchewan Plain, or Second Prairie Steppe to the northwest and southeast (Bostock, 1967). Specifically, much of the study area is located within the Missouri Coteau Upland physiographic subdivision of the Third Prairie Steppe which rises approximately 100 meters above the surrounding Saskatchewan Rivers Plain of the Second Prairie Steppe (Hart and Hunt, 1981). This study area is located approximately 130 kilometres northwest of Regina (Figure 1).

The landscape of the King George Study Area is dominated by gently-undulating to rolling till plains on the Missouri Coteau while the Saskatchewan River Plain consists of an undulating mosaic of till, lacustrine, and fluvial deposits (Hart and Hunt, 1981). The morainal deposits which predominate the topography of the King

George Study Area are characterized much as their counterparts within the Lost River Study Area. However, the highly-pitted topography generally exhibits lower relief in a less concentrated fashion across the landscape. Glaciolacustrine and glaciofluvial deposits are less abundant in this study area than within the Lost River Study Area to the north. The gently-undulating landscape associated with Stink Lake (Twp 24 R10) and the northwest corner of the study area (Twp 26 R12) represent much of the spatial extent of this terrain. Saline, fine- textured alluvial deposits are frequently associated with eroded coulee complexes within these areas. Where erosion persists along coulee slopes, some zones of slumping have occurred.

Soil development consists largely of Brown Chernozems in the King George Study Area although moister sites often support Dark Brown Chernozems. Saline soils are common across level, low-lying landscapes and within coulee complexes. Regosolic soils are associated with slump zones and deep wetlands while gleyed soils have developed adjacent to wetlands in the knob and kettle terrain.

Vegetation communities in the King George Study Area are much the same as described for the Lost River Study Area. However, as the area is typically drier, more drought-resistant species predominate (Hart and Hunt, 1981). The aspen and willow fringes typical of the Lost River Study Area wetlands are replaced by a fringe of shrubby species, such as buckbrush, silverberry and rose, or mixed grasses.

In the R.M. of King George about 83 percent of the total land area is owned or leased as farmland. As detailed in Table 2 these farmlands include a much higher portion of unimproved land (32 percent) than in the R.M. of Lost River. Improved land includes cropped areas (37 percent of total farm lands), summerfallow (30 percent) and pasture (one percent). Again, spring wheat is the predominant crop, accounting for 65 percent of acres under cultivation. It is believed that most of the remaining croplands are used to grow durum wheat and barley.

According to the District Agricultural Representative, large wetland areas in the R.M. of King George have typically not been used for agricultural purposes due to problems with salinity. Cropping of large wetlands has only occurred in about one year each decade and, for the last two years, most of these sloughs have been dry. In the south-west portion of the R.M., where the land is primarily grazing pasture, less than five percent of wetlands are hayed or cropped. In the rest of the R.M., a higher proportion (about 50 percent) of wetlands are hayed or cropped annually and, with the dry conditions of the last two years, this usage has increased to about 65 percent. In the north and east portions of the R.M., most farmers exclusively grow grain crops but neighbours with livestock are now asking permission to cut wetlands in these areas. Where the wetlands are too dry, grass production is poor, and the wetlands are generally not cut.

3.2 CLASSIFICATION AND INVENTORY OF WETLANDS

As detailed earlier, the classification and inventory of wetlands included field investigations and a mapping program based interpretation of air photos. These maps are presented in appendices II and III. Once the mapping was completed, wetland areas were identified, counted, measured in terms of area, and then classified according to the percent of wetland with emergent vegetation cover. The results of this exercise are shown in tables 3 and 4.

Wetlands occupying the Lost River Study Area are typically morainic knob and kettle-type potholes in the south half while more open-water, shallow wetlands occupy glaciolacustrine and fluvial lacustrine terrain to the north. This trend is readily illustrated in a wetland map representative of the Lost River Study Area presented in Appendix II. A summary of the agricultural capability of the land base in the Lost River Study Area is presented in Table 5. The Table shows that 44 percent of the total land area in this R.M. consists of CLI waterfowl class 1 and 2,

TABLE 3

CHARACTERISTICS OF WETLANDS IN THE LOST RIVER STUDY AREA

Wetland Type[1]	Number of Wetlands	Surface Area (ha)	Percent of Total Wetland Area (ha)	Percent of Total Area
Temporary/Seasonal Wetlands				
1	2 079	727.96	12.77	
2	1 114	546.92	9.60	
3	299	240.81	4.22	
4	72	48.62	0.85	
5	71	45.66	0.80	
6	35	18.03	0.32	
7	16	2.20	0.04	
Subtotal	3 686	1 630.20	28.60	2.91
Semipermanent Wetlands				
1	273	65.90	1.16	
2	480	339.88	5.96	
3	355	403.11	7.07	
4	156	218.18	3.83	
5	98	168.71	2.96	
6	34	48.14	0.84	
7	11	14.67	0.26	
Subtotal	1 407	1 258.59	22.08	2.25
Permanent Wetlands				
1	62	123.93	2.17	
2	56	166.70	2.92	
3	4	12.54	0.22	
4	4	7.97	0.14	
Subtotal	126	311.14	5.46	0.56

Wetland Type[1]	Number of Wetlands	Surface Area (ha)	Percent of Total Wetland Area (ha)	Percent of Total Area
Saline Wetlands				
1	1 841	2 074.94	36.40	
2	262	342.37	6.01	
3	52	56.57	0.99	
4	19	16.25	0.29	
5	6	9.92	0.17	
Subtotal	2 180	2 500.05	43.86	4.47
Total	7 399	5 699.98		10.19

[1] The wetland types refer to percent of wetland with emergent vegetation cover as follows:
0-5%=1, 6-16%=2, 16-30%=4, 61-80%=5, 81-95%=6, 96-100%=7.

TABLE 4

CHARACTERISTICS OF WETLANDS IN THE KING GEORGE STUDY AREA

Wetland Type[1]	Number of Wetlands	Surface Area (ha)	Percent of Total Wetland Area (ha)	Percent of Total Area
Temporary/Seasonal Wetlands				
1	3 140	1 166.89	19.88	
2	713	363.45	6.19	
3	474	407.65	6.95	
4	165	159.45	2.72	
5	59	40.75	0.69	
6	20	21.67	0.37	
7	4	2.19	0.04	
Subtotal	4 575	2 040.61	34.77	2.51
Semipermanent Wetlands				
1	205	109.31	1.86	
2	430	301.22	5.13	
3	496	578.46	9.86	
4	228	287.83	4.90	
5	124	159.45	2.72	
6	38	52.22	0.9	
7	3	3.06	0.05	
Subtotal	1 526	1 491.55	25.41	1.83

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Wetland Type[1]	Number of Wetlands	Surface Area (ha)	Percent of Total Wetland Area (ha)	Percent of Total Area
Permanent Wetlands				
1	57	62.85	1.07	
2	98	186.09	3.17	
3	44	83.28	1.42	
4	9	12.96	0.22	
6	1	0.36	0.01	
7	2	8.40	0.14	
Subtotal	211	344.94	5.88	0.42
Saline Wetlands				
1	678	1 492.27	25.43	
2	132	227.59	3.88	
3	51	197.92	3.37	
4	27	55.92	0.95	
5	5	7.24	0.12	
6	6	10.53	0.17	
7	1	0.43	0.01	
Subtotal	900	1 991.90	33.94	2.45
Total	7 212	5 689.00		6.99

Total Pasture Area = 30 472.48 ha
Total Agricultural Area = 50 894.43 ha

[1] The wetland types refer to percent of wetland with emergent vegetation cover as follows:
0-5%=1, 6-16%=2, 16-30%=4, 61-80%=5, 81-95%=6, 96-100%=7.

TABLE 5

SIZE AND CANADA LAND INVENTORY (CLI) CAPABILITY OF LAND BASE IN THE STUDY AREAS

	Lost River R.M.		King George R.M.	
	Hectares	Percent	Hectares	Percent
Total Land Area	57 072.1	100.0	84 484.0	100.0
Waterfowl Capability of Land Base:				
Class 1, 2	25 066.0	43.9	26 683.6	31.6
Agricultural Capability of Lands With High Waterfowl Capability				
Class 1	0.0	0.0	0.0	0.0
Class 2, 3	10 593.7	42.3	5 010.6	18.8
Class 4	8 586.2	34.2	4 941.2	18.5
Class 5, 6, 7	5 886.1	23.5	16 731.8	62.7

Source: Gierman, D.M. (1988). Targeting for Implementation of the North American Waterfowl Management Plan.

and 42 percent of these lands have a relatively high capability to support agriculture (Class 2 and 3 lands).

Wetlands occupying the King George Study Area typify the morainic knob and kettle landscape of the Missouri Coteau. Agricultural practices have occurred across much of the lacustrine and low relief morainal plain resulting in an abundance of drained wetlands existing under cultivation. A representative wetland map in Appendix III illustrates the type and distribution of wetlands in the King George Study Area. Table 4 presents a summary of wetlands and upland areas in the King George Study Area. Within this R.M., wetlands comprise about 5 700 ha and this represents about seven percent of the total land area. Typically, these lands have lower agricultural capability than in the Lost River Study Area. As described in Table 5, 63 percent of the land base is rated as Classes 5 through 7 in terms of agricultural capability. Only about 19 percent of the agricultural land base is rated as high quality waterfowl habitat (CLI 1, 2 and 3).

3.3 IDENTIFICATION OF SIGNIFICANT WETLAND FUNCTIONS

To identify significant wetland functions in each of the Study Areas, the screening questionnaire provided in Table 1 was used as a guide. By addressing each question for each study area and through a review of resource material (notably Young, 1989), a variety of information about wetland functions was produced. This information was then reviewed by the consultants to determine which types of wetland functions could be incorporated into the evaluation model and to identify any specific wetland functions that could be quantified or evaluated as part of the household survey.

3.3.1 Hydrological Functions

The Study Areas, with their knob and kettle terrain have well-contained, internal drainage. There are no well-defined watercourses that enter or exit the Study Areas. As a result, water tends to accumulate locally in wetlands and thus provides local benefits for soil moisture enhancement and potentially for groundwater recharge (Meyboom, 1966; Lissey, 1971). Similarly, wetlands in the study area certainly have the capacity to act as headwater storage areas and thereby reduce the impacts of downstream erosion and flooding. Nonetheless, as previously described, the nature of the landscape is such that runoff is retained locally.

It is likely that wetlands play a role in hydrological cycling, notably with regard to evaporation from wetlands contributing to rainfall events. Evidently, of the water that leaves wetlands, on average, 95 percent leaves by evaporation and 5 percent is directed to groundwater (D. Craig, pers. comm.). Given this scenario, it is reasonable to conclude that wetlands could contribute significantly to the generation of rainfall locally and on a regional basis in the prairies.

In terms of water quality, wetlands in the Study Areas presumably have some assimilative capacity with regard to agricultural products such as fertilizers and pesticides that enter these wetlands after rainfall or snowfall. Nonetheless, given the absence of watercourses draining the Study Areas, the benefits of wetlands filtering these substances are limited for potential downstream water quality. In a similar vein, wetlands would capture eroded soil after major run-off but opportunities for decreasing downstream suspended solid levels in receiving watercourses are limited.

Nonetheless, if these wetlands were drained, with an outlet into receiving watercourse, sediment and herbicide loading would increase as would the potential for increased flood peaks. Their very nature of not being connected to watercourses thus contributes to enhanced flood control and improved water quality.

3.3.2 Habitat Functions

The mosaic of wetland types coupled with high densities of wetlands combine to create an ecologically-rich area for wetland-oriented wildlife. For example, the wildlife groups and representative species that are known to or could be expected to frequent these wetlands include:

- semi-aquatic furbearers - e.g. beaver, muskrat
- ungulates - e.g. white-tailed deer
- shorebirds - e.g. American Avocet, Killdeer
- songbirds - e.g. Yellow-headed Blackbird, Marsh Wren
- ducks - e.g. Blue-winged Teal, Canvasback.

Rare and endangered species such as the Whooping Crane (endangered - COSEWIC, 1989) occasionally frequent this portion of Saskatchewan during spring and fall migration. Unpublished Canadian Wildlife Service data (personal communications, B. Johns) revealed that three adult Whooping Cranes were observed in the Lost River Study Area in 1972 while four adults were observed in the King George Study Area in 1981. The Burrowing Owl (threatened - COSEWIC, 1989) does not frequent wetlands but does nest in pasture lands adjacent to wetlands. Harris and Lamont (1985) reported a breeding bird in the King George Study Area. Ferruginous Hawks (threatened - COSEWIC, 1989) also frequent pasture lands near the two Study Areas but no nests are known in the immediate vicinity of these areas (personal communications, A. Smith, Canadian Wildlife Service). A Piping Plover (endangered - COSEWIC, 1989) was observed at Stink Lake in the King George Study Area in the mid-1980's (personal communications, A. Smith).

Wetland vegetation can play a major role in stabilizing shorelines and preventing erosion. Carter *et al.* (1978) described how wetland vegetation binds and stabilizes substrates, dissipates wave action and traps sediments.

From the perspective of waterfowl, the mosaic of temporary, seasonal and permanent wetlands and adjacent upland areas in the Saskatchewan prairie and parkland region have historically supported the highest concentrations of breeding ducks in North America. During the period from 1955 to 1983, the average annual number of ducks in North America was 42.3 million of which 30.7 million (72.4 percent) occurred in those portions of Saskatchewan, Alberta, Manitoba and the Northwest Territories that the Canadian Wildlife Service refers to as the Western and Northern Region (Canadian Wildlife Service, 1986). Of these approximately 31 million ducks, 35 percent have historically occurred in Saskatchewan, the largest contribution of any of the jurisdictions in the Western and Northern Region (*op. cit.*). The southern portion of Saskatchewan alone contributed an average of 28 percent of the 31 million ducks in the Western and Northern Region (*op. cit.*).

The Study Areas are perhaps best known for their duck breeding habitat. As part of the mixed prairie habitat of the Prairie Pothole Region (Bellrose, 1979), the Study Areas are representative of superior breeding habitat for ducks, particularly dabbling ducks. In his review of North American duck breeding habitat for the period 1955-1977, Bellrose (1979) described that this mixed prairie habitat supported the highest proportion of any habitat (28 percent) of North America's breeding dabbling ducks.

The Study Areas lie within Stratum 32, one of 50 physiographic units established by Canadian and United States waterfowl biologists to annually census North American breeding waterfowl and populations. As part of the Prairie Pothole Region, this stratum, during the period 1955-1974, supported a density of 4.7 ponds/km^2 as compared to 1.8 ponds/km^2 for the Prairie Pothole Regions as a whole (Bellrose, 1979). In a similar vein, Stratum 32 supported an average of 28 breeding dabbling ducks/km^2 in total and 4.3 Blue-winged Teal/km^2 versus Prairie Pothole Region averages of 5.7 dabbling ducks/km^2 and 2.8 Blue-winged Teal/km^2 (Bellrose, 1979). More recently (ie., 1970-1989), Stratum 32 supported an average of 4.1 Blue-winged Teal, 0.5 Canvasback and 28.9 total ducks/km^2 (unpublished Canadian Wildlife Service data; personal communications, A. Didiuk).

The value of this stratum and the Study Areas in particular have been recognized by the Prairie Joint Venture of the North American Waterfowl Management Plan (NAWMP) as a priority area for implementation of waterfowl habitat restoration and management programs.

3.3.3 Ecological Functions

Wetlands support high levels of net primary productivity compared to other ecosystems, and thereby provide food chain support (Sather and Smith, 1984). Wetlands also function in the capacity of plant and animal matter decomposition, nutrient export and nutrient utilization (*op. cit.*). However, no studies which detail or evaluate the importance of these functions in the two Study Areas have been identified.

The prairie pothole region, with its mosaic of wetlands and upland habitat constitutes an important ecosystem for flora and fauna. The extent to which this ecosystem has been jeopardized by degradation such as drainage is not well understood. Of particular concern is whether the ecosystem is at a threshold point beyond which further degradation will compromise the capability of that ecosystem to support its current array of flora and fauna on the long-term.

3.3.4 Socio-Economic Functions

Prior to the surveys carried out as part of this study (see Section 4.2.1), recreational activities in the two Study Areas had not been quantified. The Study Areas themselves are considered to have moderately poor to poor capability for recreation (Environment Canada, n.d.) There are no major wetlands in the Study Areas upon which high-intensity recreation would be focused and as a result, recreational activities are likely very limited.

In contrast, waterbodies such as the Cowichan Estuary in British Columbia (Ferguson *et al.*, 1989) and the Delta Marsh in Manitoba (Hochbaum, 1944; Ward, 1983) support intensive consumptive and non-consumptive recreational activities. Wetland areas are also known to provide recreational opportunities for non-consumptive resource users such as bird watchers, photographers, artists, canoeists and consumptive users such as hunters, trappers and fisherman.

Wetlands in the study area are known to generate substantial recreational opportunities in other locations, however. Migratory birds produced in the study area generate opportunities for hunting and various non-consumptive uses (i.e., birdwatching) throughout the rest of Saskatchewan and along the migratory flyways. As noted earlier, the Study Area wetlands are an important source of waterfowl for the remainder of the continent.

The prairie pothole region with its complex mosaic of wetland types and adjoining uplands constitutes a unique resource at both the regional and national level. There is growing interest by society to conserve and restore wetlands as evinced by numerous programs such as the North American Waterfowl Management Program and Ducks Unlimited Canada's Prairie Care program which are designed to maintain and enhance this valuable resource.

3.3.5 Agriculture Functions

A specific subset of socio-economic functions are various agricultural uses of wetlands. Although there was no documentation of agricultural use of wetlands in the two Study Areas prior to this study, there is general recognition that farmers use wetlands as a source of water for livestock, irrigation and domestic uses (Cowan, 1981a; Ducks Unlimited, 1985). In addition, native wetland vegetation was found to provide good pasturage (Lakshman, 1979) and is often used for forage. At the Kitsim Complex, near Brooks, Alberta, management of 65 small wetlands to provide waterfowl habitat also resulted in a 300 percent increase in forage production with 77 percent higher protein levels than unmanaged basins and prairie uplands (Sankowski *et al.*, 1987). At a more general level, there is growing evidence that the mere presence of wetlands and associated evaporation may be contributing to local and regional rainfall, thereby providing another source of improving soil moisture conditions in an indirect manner.

While a detailed description of agricultural uses of wetlands in the two Study Areas is provided later in the analysis (Section 5.5), farmers were found to use wetlands for hay production, crops, pasturage, water supply and various other purposes.

3.3.6 Educational Functions

Wetlands provide laboratories for research and education (Young, 1989). For example, the Delta Waterfowl and Wetlands Research Station in Manitoba supports ongoing graduate research studies which are contributing to better understanding of ecological processes and management techniques. Similarly, wetlands such as Nichol Flats in Southern Saskatchewan are used extensively by elementary and high school classes to gain appreciation of wetland and general ecological values.

While wetlands in the two Study Areas have the potential for providing a similar educational function, there are no such uses of these areas at the present time.

3.3.7 Summary

Table 6 contains a summary of relevant and significant functions for wetlands in the Study Areas. The table shows that, while prairie pothole wetlands are known to serve most of functions identified, there is limited data with which to assess and evaluate the importance of these functions for wetlands in the Lost River and King George Study Areas. In fact most of the existing information addresses only a limited range of habitat, socio-economic and agricultural functions to any degree, and some of this information was developed during the conduct of this study. Thus, the remainder of this analysis focuses only on the limited range of functions for which there was information or for which information could be easily obtained.

TABLE 6

SUMMARY OF WETLAND FUNCTIONS IN THE PRAIRIE POTHOLE STUDY AREAS

Function	Evaluation Criteria	Rating/Comments
Hydrological Functions:	1. Does the wetland contribute to recharge of aquifers?	Likely
	2. Does the wetland provide any flood protection benefits	Possibly
	3. Will a change to the wetland enhance or reduce water discharge or recharge of groundwater	Yes
	4. Does the wetland provide a natural water purification process?	Yes
	5. Does the wetland(s) contribute to hydrological cycling (i.e. rainfall)?	Yes
Habitat Functions:	1. Are there any rare, threatened or endangered species present?	Yes
	2. Does the wetland provide protection of natural shorelines?	Yes
	3. Does the wetland contain high quality habitats for waterfowl?	Yes
	4. Does the wetland contain high quality habitats for other species?	Yes
Ecological Functions:	1. Is the wetland important ecologically in terms of functions such as ecological diversity, oxygen generation and nutrient recycling?	Yes
	2. Does the wetland support an extensive ecosystem complex including uplands?	Yes
	3. Has a threshold been reached where the integrity of wetland ecosystems will be compromised by further degradation?	Possibly

Function	Evaluation Criteria	Rating/Comments
Socio-Economic Functions:	1. Is the wetland used for commercial hunting, trapping and fishing?	Possibly
	2. Does the wetland provide opportunities for non-commercial use of fish, wildlife and/or water resources?	Yes
	3. Does the wetland represent an important local, regional or provincial tourism or recreation attraction?	Yes
	4. Is the wetland part of the pattern of settlement and rural lifestyles?	Yes
	5. Is the wetland used as a commercial source of peat?	No
	6. Are there other commercial uses of wetlands, such as harvesting opportunities for wild rice or cranberries?	No
	7. Can the forest resources in the wetland be harvested?	No
	8. Is the wetland(s) a unique national or regional resource?	Yes
	9. Are there national or regional policies/programs to support conservation/restoration of wetlands?	Yes
Agriculture Functions:	1. Is the wetland used as a source of forage?	Yes
	2. Does the wetland serve to reduce topsoil erosion?	Likely
	3. Does the wetland serve to improve soil moisture?	Yes
	4. Is the wetland used as a source of on-farm water supply	Yes
Educational Functions:	1. Is the wetland used for scientific research?	No
	2. Is the wetland used for educational purposes?	Possibly

4.0 EVALUATION OF WETLAND FUNCTIONS IN THE STUDY AREAS

Based on the screening process, wetlands in the study areas appear to provide two significant types of wetland functions that can readily be identified and evaluated: wildlife habitat and recreation. While these wetland areas undoubtedly contribute in other ways, these other functions are not amenable to easy quantification or evaluation. In order to provide a credible wetland evaluation process, a quantitative approach was considered preferable and as such the following analysis deals primarily with an evaluation of the wildlife habitat and recreational functions of wetlands in the study areas.

4.1 WILDLIFE HABITAT

4.1.1 Waterfowl

Evaluation of study area wetlands was accomplished using a Habitat Evaluation Procedure (HEP) approach to quantifying wildlife habitat capability. This approach rates habitat capability on a linear scale of 0 to 1.0, with 1.0 representing optimal habitat. Wildlife habitat capability and rating was based on species (Blue-winged Teal and Canvasback) which are representative of the general habitat requirements of other wetland-oriented wildlife.

In the case of Blue-winged Teal, this species prefers temporary/seasonal wetlands for pairing habitat, more permanent water for brood-rearing, and wetland fringe vegetation (primarily grasses) for nesting. In contrast, Canvasbacks rely much more strongly upon more semi-permanent and permanent wetlands for pairing and brood rearing. A well-developed emergent vegetation zone (e.g. cattail) is essential for nesting and brood-rearing.

These habitat preferences are reflected in the HEP models utilized for this study. Tables 7 and 8 present the evaluations of habitat capability for these two species on a township and Study Area basis.

Habitat capability or Habitat Suitability Index (HSI) values for Blue-winged Teal were similar for the two Study Areas (0.62 for Lost River and 0.66 for King George; Table 7). Overall, these study area values represent better than average Blue-winged Teal breeding habitat. This evaluation closely matches the results provided by Bellrose (1979) in his evaluation of Blue-winged Teal population densities for Stratum 32 which incorporates the two Study Areas.

HSI values for Blue-winged Teal in the Lost River Study Area townships ranged from 0.29 (relatively poor habitat) to 1.0 (optimal habitat), with nesting cover representing the limiting factor. Nesting cover here was restricted because of the predominance of cultivated fields (see Appendix II).

In the King George Study Area, HSI values ranged from 0.10 (very poor habitat) to 1.0 (optimal habitat), with pairing habitat representing the predominant limiting factor. Pairing habitat was limited by the paucity of wetlands in certain townships (see Appendix III).

The quality of Canvasback breeding habitat was similar for the two Study Areas (Table 8). Overall the 0.79 and 0.76 HSI values represented high-quality breeding habitat. HSI values within the Lost River Study Area ranged from 0.63 (above average) to 1.0 (optimal habitat). The lack of pair/brood habitat in the form of permanent wetlands with a well-developed emergent zone limited the suitability of habitat (see Appendix II). In the King George Study Area, HSI values ranged from 0.25 (poor habitat) to 1.0 (optimal habitat). Again the paucity of permanent wetland in some townships reduced habitat suitability (see Appendix III).

TABLE 7

RANKING OF BLUE-WINGED TEAL BREEDING HABITAT FOR THE PRAIRIE POTHOLE WETLANDS STUDY AREA

Township	Range	Calculated HSI (Lowest)[1]	Normalized HSI[2]	Limiting Factor[3]
Lost River Study Area				
31	01	0.21	1.00	NLF
31	02	0.21	1.00	NLF
32	01	0.10	0.48	N
32	02	0.11	0.52	N
33	01	0.06	0.29	N
33	02	0.09	0.43	N
Study Area Mean		0.13	0.62	
King George Study Area				
24	10	0.09	0.43	P
24	11	0.19	0.90	P
24	12	0.14	0.67	P
25	10	0.20	0.95	P
25	11	0.21	1.00	NLF
25	12	0.15	0.71	N
26	10	0.15	0.71	P
26	11	0.10	0.48	N
26	12	0.02	0.10	P
Study Area Mean		0.14	0.66	

[1] Calculated HSI value utilizing the Blue-winged Teal Model (Sousa 1985). HSI values range from 0 to 1.0, with 1.0 representing optimum conditions for supporting the highest potential observed densities of a species within a defined area, and 1, representing no suitable habitat. With this linear relationship, habitat with an HSI value of 0.8 has the potential to support twice the density of animals as a habitat type with an HSI of 0.4.

[2] Determined by dividing the lowest calculated HSI value for each township by 0.21, the highest calculated value in the column.

[3] Life requisite that is the limiting factor within the township: P = Pairing Habitat, N = Nesting Habitat, NLF = No Limiting Factor.

TABLE 8
RANKING OF CANVASBACK BREEDING HABITAT FOR THE PRAIRIE POTHOLE WETLANDS STUDY AREAS

Township	Range	Normalized HSI[1]	Limiting Factor[2]
Lost River Study Area			
31	01	1.00	NLF
31	02	0.77	P/B
32	01	0.88	P/B
32	02	0.87	P/B
33	01	0.61	P/B
33	02	0.63	P/B
Study Area Mean		0.79	
King George Study Area			
24	10	0.72	P/B
24	11	0.85	P/B
25	12	0.81	P/B
25	10	0.98	P/B
25	11	0.96	P/B
25	12	0.63	P/B
26	10	1.00	NLF
26	11	0.67	P/B
26	12	0.25	P/B
Study Area Mean		0.76	

[1] HSI values derived from Canvasback model (Schroeder 1984). HSI values range from 0 to 1.0, with 1.0 representing optimum conditions for supportingthe highest potential observed densities of a species within a defined area, and 0, representing no suitable habitat. With this linear relationship, habitat with an HSI value of 0.8 has the potential to support twice the density of animals as a habitat type with an HSI of 0.4.

HSI values modified with an area weighted factor such that:

- sections within each township with no wetlands were weighted by a factor of zero.
- sections within each township lacking semi-permanent wetlands were weighted by a factor of 0.2;

[2] Life requisite that is the limiting factor within the township: P/P = Pair/Brood Habitat, NLF = No Limiting Factor.

While HEP provides a ranking of wetlands in terms of habitat capability, it is also necessary to consider factors like habitat scarcity when providing a full evaluation of wetland function. To augment the HEP approach, a second method, which was adopted by Ferguson *et al.* (1989) for the Cowichan Estuary, involved evaluating wetlands based on habitat capability and habitat scarcity ratings. Use of this method provides the opportunity to compare the results of the Prairie Pothole Wetland study with the results from some of the other pilot studies.

The Ferguson et al. (1989) habitat capability rating scale ranged from 1 to 5, with 5 representing the highest capability. A second scale, based on scarcity (also 1 to 5) identified the amount of wetland habitat of a given type relative to the total wetland habitat in the study area[10]. The final task in the wetland rating scheme involves multiplying the capability rating by the scarcity rating to obtain an overall rating. The scale used to derive this final rating is:

CAPABILITY RATING 5 = High Capability
3 = Moderate Capability
1 = Low Capability

SCARCITY RATING 5 = <5 percent of Total Wetland Habitat
3 = 5 - 20 percent of Total Wetland Habitat
1 = >20 percent of Total Wetland Habitat

Evaluating wildlife habitat, specifically wetland bird habitat, using the Ferguson *et al.* (1989) rating methodology is feasible but there are some limitations with this approach. Wetland habitat requirements tend to vary among species or groups of wildlife (e.g. Blue-winged Teal and Canvasback) and thus it is difficult to apply the Ferguson *et al.* (1989) rating scheme to individual wetland types when, for example, temporary/seasonal wetlands are highly valuable to Blue-winged Teal and species with similar habitat requirements while permanent wetlands are highly important to species such as the Canvasback.

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[10] As Ferguson *et al.* (1989) have correctly identified, wetlands are complex environments and their value does not lie exclusively within a single wetland type but frequently is dependent upon the presence of a diversity of wetlands and associated habitats.

The net result of this evaluation process is to provide a methodology that rates wetlands in terms of habitat quality based on their capability to support a broad diversity of wetland-oriented wildlife. The results of this analysis are shown in Table 9 which illustrates that temporary/seasonal, semi-permanent and permanent wetlands are rated highly, while saline intermittent wetlands have a low rating.

4.1.2 Other Species

The Study Areas have been studied only to a very limited degree for other wildlife species. Some information on rare and endangered species does exist (COSEWIC, 1989) and has been documented in Section 3.3.2.

4.2 RECREATIONAL USE AND VALUES

To evaluate the recreational functions of wetlands in the Study Areas, two different methodologies were employed. The first relates to assessing the recreational capability of wetlands in each study, as determined by biophysical characteristics and accessibility to the recreational user.

Unlike the Cowichan Estuary (Ferguson *et al.*, 1989), the Prairie Pothole Study Areas involve broad expanses of land, with individual wetlands interspersed throughout a pasture or cropland-dominated landscape (see appendices II and III). The characteristics of this landscape do not lend themselves to either varied or

TABLE 9

RATING OF WETLANDS IN THE PRAIRIE POTHOLE WETLANDS STUDY AREAS IN TERMS OF WILDLIFE HABITAT

Study Area Wetland Type	Capability Rating	Scarcity Rating	Total Rating
Lost River Study Area			
Temporary/Seasonal	5	1	5
Semi-permanent	5	1	5
Permanent	5	3	15
Saline	1	1	1
King George Study Area			
Temporary/Seasonal	5	1	5
Semi-permanent	5	1	5
Permanent	5	3	15
Saline	1	1	1

Rating Scale:

Capability	Scarcity
5 = high	5 = <5% of total wetland area
3 = medium	3 = 5-20% of total wetland area
1 = low	1 = >20% of total wetland area

Capability Rating = Relative diversity of wetland physical characteristics that would contribute to supporting a wide variety of wetland oriented wildlife.

Scarcity Rating = Relative abundance of wetland type.

concentrated recreational opportunities. Rather, for example, activities such as hunting or nature walks would occur in the Study Areas as uncommon events and could occur in just about any location within the 15 townships that comprise the two Study Areas. It is likely that the above-described recreational activities would more likely occur in a landscape with high concentrations of wetlands within a pasture land environment where native habitat, rather than agriculture, predominates.

As a result, evaluating the recreational capability of small, often widely-separated wetlands is not as appropriate as an overall evaluation of the landscape and its mosaic of wetlands. It is this mosaic of wetland forms and the diverse assemblage of wildlife associated with these wetlands that provides the potential for recreational opportunities. Thus, although individual wetland types are rated for recreational capability, the Study Areas as a whole were also rated based on the diversity and density of wetlands present (Table 10).

For the purposes of this evaluation, semi-permanent and permanent wetlands are assigned a higher rating because of the presence of water throughout the summer and fall while temporary/seasonal wetlands are assigned a moderate rating; saline wetlands individually have a low capability.

Although the Study Areas as a whole were rated rather low, certain locations within each study area with high wetland densities (see appendices II and III) have a higher potential for supporting certain recreational activities, notably nature interpretation. While the Study Areas do not incorporate cities or even towns, they are relatively near to urban centres such as Saskatoon and Regina. Thus, there are some substantial population bases that could be drawn upon as a source of visitors interested in nature walks and some waterfowl hunting activities.

TABLE 10

RATING OF WETLANDS IN THE PRAIRIE POTHOLE WETLANDS STUDY AREAS IN TERMS OF RECREATION

Study Area Wetland Type	Capability Rating	Scarcity Rating	Total Rating
Lost River Study Area			
Temporary/Seasonal	3	1	3
Semi-permanent	5	1	5
Permanent	5	3	15
Saline	1	1	1
King George Study Area			
Temporary/Seasonal	3	1	3
Semi-permanent	5	1	5
Permanent	5	3	15
Saline	1	1	1
Total Study Area	1	3	3

Rating Scale:	Capability	Scarcity
	5 = high	5 = <5% of total wetland area
	3 = medium	3 = 5-20% of total wetland area
	1 = low	1 = >20% of total wetland area

•Capability Rating = Relative abundance of wildlife and natural landscape features, and the opportunity for public access to the features.

Scarcity Rating = Relative abundance of wetland type.

The second methodology for evaluating the recreational functions of wetlands was the use of a household survey to collect information on actual use of wetlands in the two Study Areas. As noted earlier, a random sample of about 100 households within a 24-kilometre (15-mile) radius of each of the R.M.'s was contacted and interviewed, as detailed in Appendix I. To gain a broader perspective, a similar but separate sample of about 250 households from across southern Saskatchewan was also interviewed. The geographical boundaries used as the basis for these surveys are shown in Figure 2.

While the survey results were used to generate estimates of wetland use and the economic values associated with this use, there are some limitations to the reliability of the resulting information:

- First, the results only address potential wetland users who reside in Southern Saskatchewan. Other beneficiaries, like migratory bird hunters in other jurisdictions, fall outside the survey population so this aspect of recreational use of wetlands is not addressed by the survey.

- Second, only half of potential households selected for interviews were actually contacted and, of these, one-third refused to participate. Thus, there is some potential for non-response bias although no consistent or obvious reasons for refusals were given, aside from lack of interest. An examination of general demographic characteristics (age, household size) indicates that the sample population does resemble the general population characteristics, however.

- Third, respondents were asked to speak on behalf of their entire household. While cost-effective, this approach does reduce the extent to which responses are truly representative of the survey population. The potential for bias is greater for opinion-related questions than for factual data.

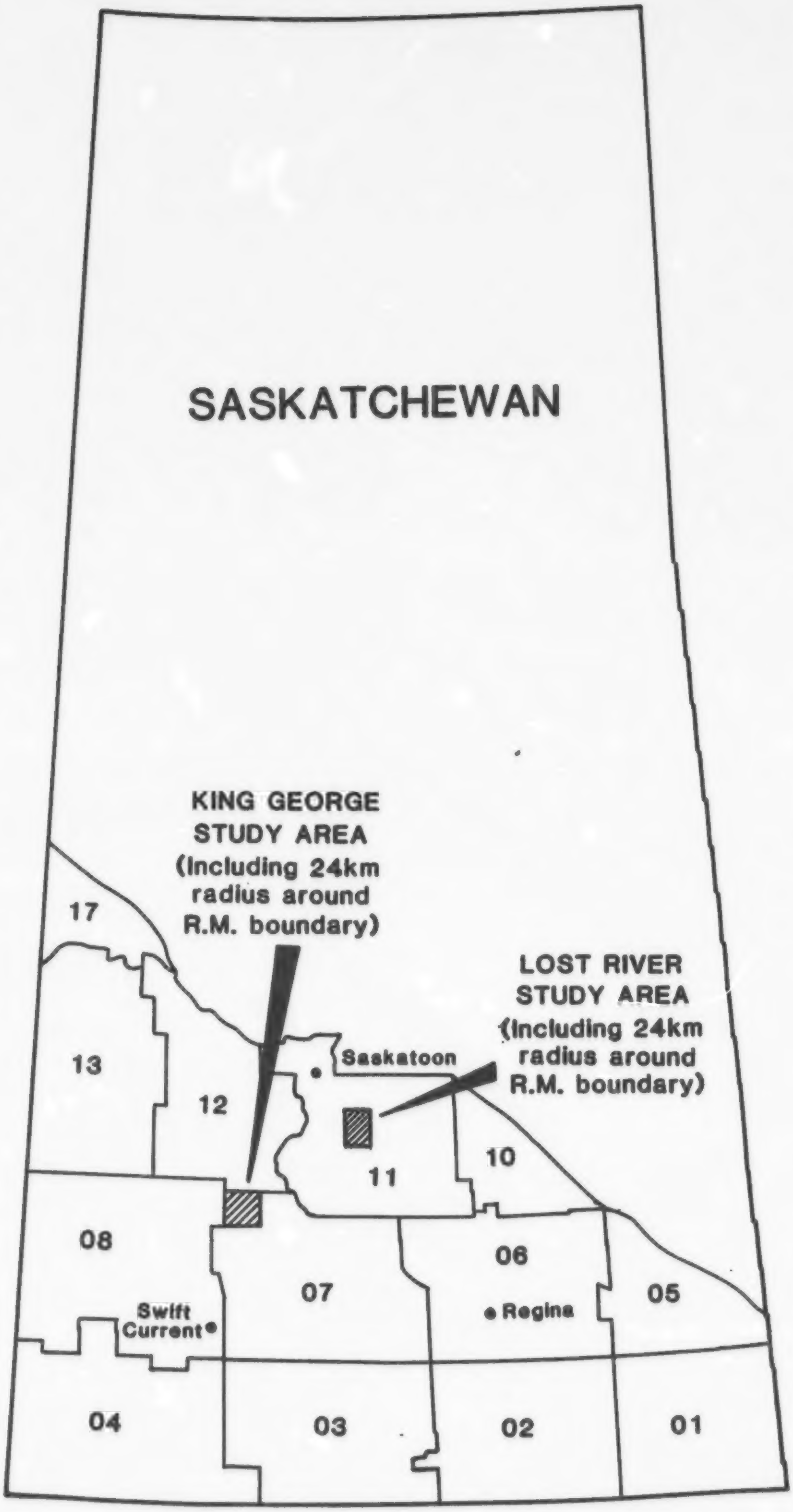

SASKATCHEWAN
KING GEORGE STUDY AREA (Including 24km radius around R.M. boundary)
LOST RIVER STUDY AREA (Including 24km radius around R.M. boundary)
Saskatoon
Regina
Swift Current
17
13
12
11
10
08
07
06
05
04
03
02
01

Figure 2. Geographical Boundaries Used For The Household Surveys

- Fourth, the sample sizes for some specific target groups within the overall survey population were sometimes quite small. While statistics for these groups have been reported, these results must be used with considerable caution, especially when a sample size of less than 30 is involved. For certain estimates of key parameters, 95 percent confidence intervals have been provided to demonstrate the reliability of the survey results.

4.2.1 Recreational Use

Survey results pertaining to use of wetlands in the study area are summarized in Table 11. The data show that, while about one-third of the people living in southern Saskatchewan visited wetlands for recreational or other purposes, the proportion who visited wetlands in the study area was quite small, only 4.9 percent. At a regional level, the percentage of households that visited wetlands for recreational purposes was higher, especially households in the Lost River Study Area. The proportion of regional households that visited wetlands in the study area was at least twice as great.

Using the data in Table 11, it is estimated that total recreational activity at wetlands in the two Study Areas amounted to about 110 900 user-days during 1989. This estimate would include about 12 700 user-days for residents of the Lost River Study Area and 3 400 user-days for people living in the King George Study Area.

According to the results in Table 12, wetlands in the Study Areas appear to used most for passive forms of recreation such as viewing scenery. At least 30 percent of wetland users from both regions and from southern Saskatchewan listed viewing scenery as their primary reason for visiting wetland areas. Hunting represented the second most common reason for visiting wetlands in the Study Areas. Hunting was more prevalent among local area residents, especially in the Lost River area, than for residents of southern Saskatchewan. For regional residents, other important

TABLE 11

HOUSEHOLD USE OF WETLANDS IN THE LOST RIVER AND KING GEORGE STUDY AREAS: SURVEY RESULTS

Households Residing In	Lost River Study Area	King George Study Area	Southern Saskatchewan
Number of Households[1]	4 255	4 945	372 200
Sample Size	100	100	246
Percent That Visited Any Wetland Areas in Sask.	48.0 (±9.8)	37.0 (±9.5)	33.2 (±5.9)
Percent that Knew of the Two Study Areas	30.0 (±9.0)	27.0 (±8.7)	11.8 (±4.0)
Percent That Visited Wetlands in the Study Areas	19.0 (±7.7)	9.0 (±5.6)	4.9 (±2.7)
Average Visits Per Year	5.2 (±3.1)	3.4 (±2.5)	2.0 (±0.8)
Average Party Size	3.7 (±0.9)	2.2 (±0.5)	2.9 (±0.7)
Total Visitation	12 700 (±9 200)	3 400 (±3 340)	110 900 (±78 300)

[1] Estimates of the number of households come from census estimates. In the case of the estimate for southern Saskatchewan, the estimate is based on an adult population of 690 000 and the observation, from the survey data, that there were 1.85 adults per household.

TABLE 12

NATURE OF WETLAND USE IN THE STUDY AREAS
(Percent of Households that Made Visits)

Households Residing In	Lost River Study Area (n = 19)	King George Study Area (n=9)	Southern Saskatchewan (n = 12)
Viewing Scenery	31.6	33.3	41.7
Hunting	21.1	33.3	16.7
Bird Watching	5.3	22.2	0.0
Hiking/Walking	10.5	0.0	16.7
Fishing	15.8	0.0	0.0
Enjoying Nature	0.0	11.1	0.0
Other	15.8	0.0	24.0
TOTAL	100.0	100.0	100.0

Note: Other includes camping, picnicking, visiting relatives, golfing and passing through.

recreational uses of wetlands included bird watching, fishing and enjoying nature. Walking and hiking in wetlands in the Study Areas was found to be more common for provincial residents than for regional residents.

Table 13 provides an indication of which of the two wetland Study Areas were utilized by each of the three respondent groups. For the regional populations, the adjacent wetland areas received most of the usage although some visits were made to wetland areas in the other R.M. For households in southern Saskatchewan, however, wetlands in the R.M. of King George appear to get more usage than wetlands in the Lost River area, and this may reflect a greater travel distance for households in the more southerly part of the province to travel to the more northerly of the two wetland areas.

To put the estimates of wetland visitation for the two Study Areas into perspective, Table 14 summarizes survey results pertaining to annual use of all wetland areas, including those in the two Study Areas. The data suggest total wetland visitation for recreational purposes by residents of southern Saskatchewan during the 12 months preceding the survey amounted to about 3.1 million user-days. This means that the two Study Areas accounted for about 3.6 percent of total wetland visits. Similarly, wetlands in the two Study Areas accounted for about 14 percent of all wetland recreation for residents of the Lost River area and 6 percent for residents of the King George area.

Table 14 also shows that households that use wetland areas for recreational purposes tend to do so quite regularly each year, making an average of about 10.7 visits. These visits necessitate travelling a distance of about 90 kilometres, although residents of the Lost River area reported travelling only about 65 kilometres.

TABLE 13

USE OF STUDY AREA WETLANDS BY SURVEY HOUSEHOLDS

(Percent of Households)

Wetland Area Visited	Residence of Respondent		
	Lost River Study Area	King George Study Area (n = 9)	Southern Saskatchewan (n = 12)
Lost River	15.0	0.0	0.4
King George	1.0	7.0	2.8
Both	3.0	2.0	1.6
Total	19.0	9.0	4.9

TABLE 14

HOUSEHOLD USE OF ANY WETLAND AREAS: SURVEY RESULTS

Households Residing in	Lost River Study Area	King George Study Area	Southern Saskatchewan
Number of Households	4 255	4 945	372 200
Sample Size	100	100	246
Percent That Visited Wetlands	48.0 (±9.8)	37.0 (±9.5)	33.2 (±5.9)
Average Visits Per Year	14.5 (±6.1)	10.7 (±4.8)	10.7 (±3.6)
Average Travel Distance (kms)	65.4 (±44.7)	99.2 (±48.5)	91.2 (±24.8)
Average Party Size	4.2 (±1.9)	3.0 (±0.6)	2.8 (±0.3)
Total Visitation	87 900 (±43 700)	61 100 ±(46 100)	3 070 500 (±1 023 800)

As detailed in Table 15, about 20 percent of visits to wetlands by residents of Southern Saskatchewan consisted of overnight trips which lasted an average of about 2.1 days. The remainder were day trips which lasted an average of 4.3 hours. Similar visitation patterns were reported for residents of both the Lost River and King George Study Areas.

Table 16 shows that, while hunting represents the most common recreational use of wetland, other activities like viewing scenery, hiking/walking and bird watching were nearly of equal importance.

The patterns of wetland usage derived from the survey data are consistent with the results of other information pertaining to consumptive and non-consumptive wildlife utilization by Saskatchewan residents. For example, Table 17 shows that, in 1987, about 18 percent of Saskatchewan residents participated in a trip specifically for purposes of wildlife observation (primary non-consumptive), 46 percent encountered wildlife while on a trips for some other purpose, and 11 percent actually hunted wildlife. The proportion of households participating in these activities has increased by several percent since 1981, with the exception of hunting which has declined in popularity.

Table 17 also shows the average annual extent of participation in each of these consumptive and non-consumptive uses of wildlife. Average usage amounted to between 16 and 19 days in 1987 for incidental and purposeful wildlife encounters. This represents a marginal increase in wildlife usage since in 1981. In comparison, average hunting amounted to only 13 days per year in 1987 and this represents a decrease since 1981.

When these participation rates are applied to the 690 000 adults in the southern Saskatchewan survey area, the following estimates of wildlife utilization (in user-days) can be estimated for 1987:

TABLE 15

WETLANDS VISITATION CHARACTERISTICS

Households Residing in	Day Visits		Overnight Visits	
	Percent of Visits	Length of Stay (Hours)	Percent of Visits	Length of Stay (Days)
Lost River Study Area (n = 48)	82.2	3.59	17.8	3.6
King George Study Area (n = 37)	86.5	2.38	13.5	3.1
Southern Sask. (n = 78)	80.0	4.32	20.0	2.1

TABLE 16

PRIMARY REASONS FOR VISITING WETLAND AREAS
(Percent of Households That Made Visits)

Households Residing In	Lost River Study Area (n = 48)	King George Study Area (n = 137)	Southern Saskatchewan (n = 82)
Viewing Scenery	29.2	13.5	13.3
Hunting	14.6	13.5	18.0
Bird Watching	12.5	13.5	12.0
Hiking/Walking	6.3	10.8	13.3
All of the Above	6.3	0.0	10.8
All Except Hunting	6.3	8.2	9.6
Fishing	12.5	16.2	2.4
Canoeing/Boating	4.2	0.0	2.1
Visiting Friends	2.1	2.7	1.2
Farming	0.0	0.0	3.6
Other	6.0	21.6	13.7
TOTAL	100.0	100.0	100.0

Note: Others include camping, picnicking, horse riding, golfing holidays, leisure, and get away from the city.

TABLE 17

IMPORTANCE OF WILDLIFE TO RESIDENTS OF SASKATCHEWAN

	Saskatchewan		Canada	
	1981	1987	1981	1987
Percentage of Population Participating in:				
Primary Non-Consumptive Trips	16.7	18.3	19.4	22.0
Incidental wildlife encounters	45.2	45.7	43.9	45.5
Hunting wildlife	14.8	10.9	9.8	8.4
Time Spent (Days/Year):				
Primary Non-Consumptive Trips	15.9	16.1	15.8	16.9
Incidental wildlife encounters	17.6	18.8	18.8	19.2
Hunting	16.1	13.0	17.9	17.0

Source: Environment Canada (1983). The Importance of Wildlife to Canadians in 1981: Highlights of a National Survey. Canadian Wildlife Service.
Environment Canada (1989b). The Importance of Wildlife to Canadians in 1987: Highlights of a National Survey. Federal Provincial Task Force for the 1987 National Survey on the Importance of Wildlife to Canadians.

Primary Non-consumptive Trips	2 032 900
Incidental wildlife encounters	5 928 200
Hunting	977 700
Total	**8 938 800**

When this estimate is compared with the previous estimate of 3.1 million user-days of wetland recreation for the same segment of the Saskatchewan population, the results suggest that wetland experiences could account for about 34 percent of total wildlife encounters in Saskatchewan. This estimate clearly attests to the importance of wetland areas in Saskatchewan.

4.2.2 Recreational Values

One of the main objectives of the survey program was to quantify the economic values associated with recreational uses of wetlands by the survey populations. Accordingly, two questions related to the value of wetlands were incorporated into the survey. One question pertained to wetlands in general while the other question focused on wetlands in the Study Areas.

In both cases, a contingent behaviour process (contingent valuation) was employed to determine the recreationist's willingness-to-pay for the recreational experience associated with wetlands, recognizing that these wetlands can currently be used for recreational purposes with no cost of entry for the user. This process involved questioning people about how their behaviour, as expressed in terms of the number of times they would have visited wetlands during the past 12 months, would have changed had they been forced to pay an entry fee, just as entry fees are paid for movies or sporting events. A question about the daily access charge at which they would have ceased making wetland visits was also included. (Details of the survey are included as Appendix I).

The use of a willingness-to-pay approach for valuation of non-market resources has generally been recognized as an appropriate methodology and, in the case of the "Wetlands Are Not Wastelands" program, this approach has always been used. However, use of willingness-to-pay tends to infer that users have no rights to the resources in question, so that they would be forced to purchase the rights to continue using these resources. An alternative valuation approach is based on the concept of willingness-to-sell, which presumes that users do have rights to use resources and that they should receive compensation if access to resources like wetlands were to be denied or the resource were to be used for some alternative purpose. Unfortunately, studies have shown that willingness-to-sell and willingness-to-pay for the same resource tend to be different, with requests for compensation for resource losses always exceeding willingness-to-pay by a factor of at least two. In fact, studies by Bishop and Heberlein (1979) found that willingness to sell values for goose hunting were 4.8 times higher than willingness to pay while Hammack and Brown (1974) estimated the differential to be a factor of 4.2, based on surveys of waterfowl hunters in the U.S.

In the case of wetlands, we are faced with the problem of losing wetlands to competing land uses, like agriculture, so that valuation questions relating to willingness-to-sell should be used to determine wetland values. However, the experience in formulating and asking questions based on willingness-to-sell is quite weak and there is little consensus about the reliability of the results. On the other hand, there is considerable literature pertaining to correct formulation of questions based on willingness-to-pay and, for this reason, this approach has also been used in the prairies pothole wetlands study. In doing so, it must be acknowledged that the resulting estimates seriously undervalue the recreational contributions of wetlands.

Estimates of the values derived from wetland recreation are provided in Table 18. For wetland areas in general, the average willingness-to-pay for a day of recreation

TABLE 18

VALUE OF WETLAND RECREATION
(1989 Dollars)

Households Residing In:	Lost River Study Area	King George Study Area	Southern Saskatchewan
All Wetland Areas:			
Average Benefit Per User-Day	$6.30 (±1.85)	$4.59 (±1.09)	$5.03 (±1.23)
Median Value Per User-Day	4.50	4.17	3.50
Total Recreational Benefits:	$451 400 (±300 600)	$209 800 (±161 000)	$14 691 500 (±5 513 900)
Sample Size	47	37	71
Wetlands in the Study Areas:			
Average Benefit Per User-Day	$9.33 (±7.79)	$8.40 (±4.40)	$6.37 (±3.84)
Median Value Per User-Day	6.42	6.50	5.00
Total Recreational Benefits:	$72 400 (±44 000)	$23 800 (±23 400)	$457 100 (±455 600)
Sample Size	18	9	12

Note: Total recreational benefits have been estimated based on extrapolation of sample results. This total could have been estimated as the product of total visitation (tables 10 and 13) and average daily values, but this method produced higher variation.

amounted to about $5.26 per user-day for residents of southern Saskatchewan. For residents of the two study regions, the value of recreation was slightly higher ($6.30) in the case of households in the Lost River areas and lower ($4.60) for people in the King George area. These differences are not statistically significant, however. The median values generated from the sample results are also provided in Table 18 and in all cases these values were lower than the average values. This difference is particularly significant in the case of the sample of households from Southern Saskatchewan and is caused by a small portion of the sample reporting high values which skews the results. Given the small sample size, these "outliers" have been retained in the analysis.

The values in Table 18 have been derived by establishing the demand curves for individual recreationists, calculating the consumer' surplus benefits for each, and then deriving an average daily value based on reported levels of wetland visitation for the previous year. Aggregate demand curves for recreational use of wetlands in each Study Area are provided as figures 3 to 8. While the daily values in Table 18 provide an indication of the average importance of a day of wetland recreation, any action that affects the quantity or quality of recreation at that site will cause a change in the shape of the demand curve. By comparing new and old demand curves, the marginal change in value associated with a change in supply can be assessed and, in the case of losing or restoring wetland areas, it is the marginal change in value that is important. Unfortunately, these values tend to be site-and circumstance-specific, and for this study it was impossible to evaluate the importance of specific wetland areas within the overall wetland complex. Thus, average daily values have been used in the remainder of the analysis although a measure based on marginal values would have been more appropriate.

Figure 3

DEMAND CURVE FOR WETLAND RECREATION IN ALL LOCATIONS BY SURVEY HOUSEHOLDS IN THE LOST RIVER STUDY AREA (Sample Size = 48)

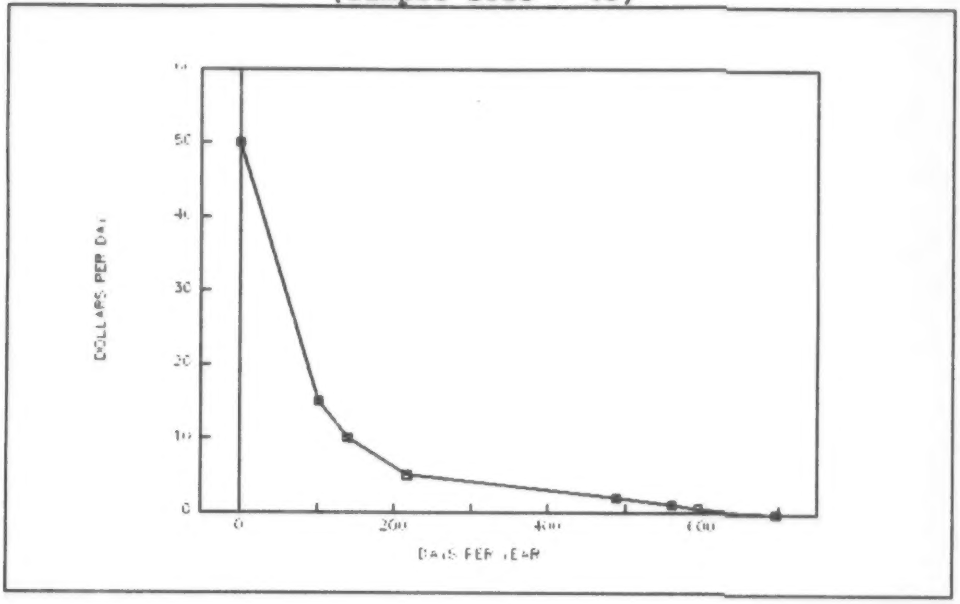


Figure 4

DEMAND CURVE FOR WETLAND RECREATION IN ALL LOCATIONS BY SURVEY HOUSEHOLDS IN THE KING GEORGE STUDY AREA (Sample Size = 37)

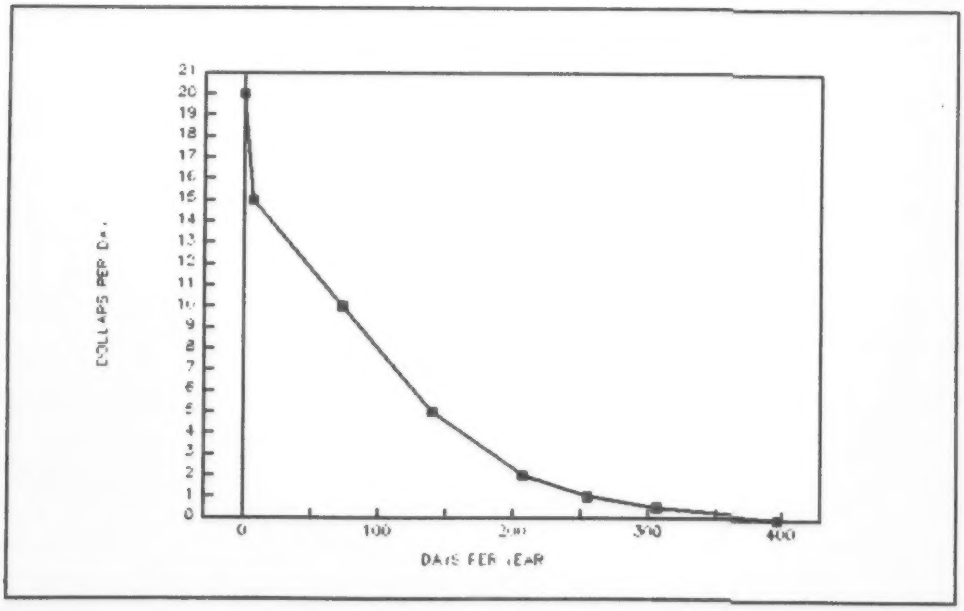


Figure 5

DEMAND CURVE FOR WETLAND RECREATION IN ALL LOCATIONS BY SURVEY HOUSEHOLDS IN SOUTHERN SASKATCHEWAN
(Sample Size = 71)

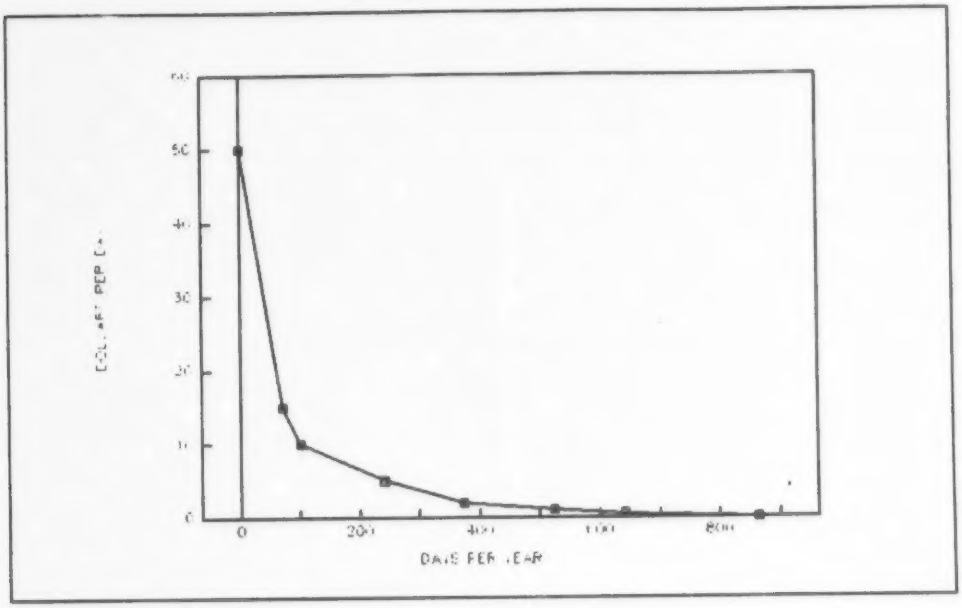


Figure 6

DEMAND CURVE FOR WETLAND RECREATION IN THE STUDY AREAS BY SURVEY HOUSEHOLDS IN THE LOST RIVER STUDY AREA
(Sample Size = 19)

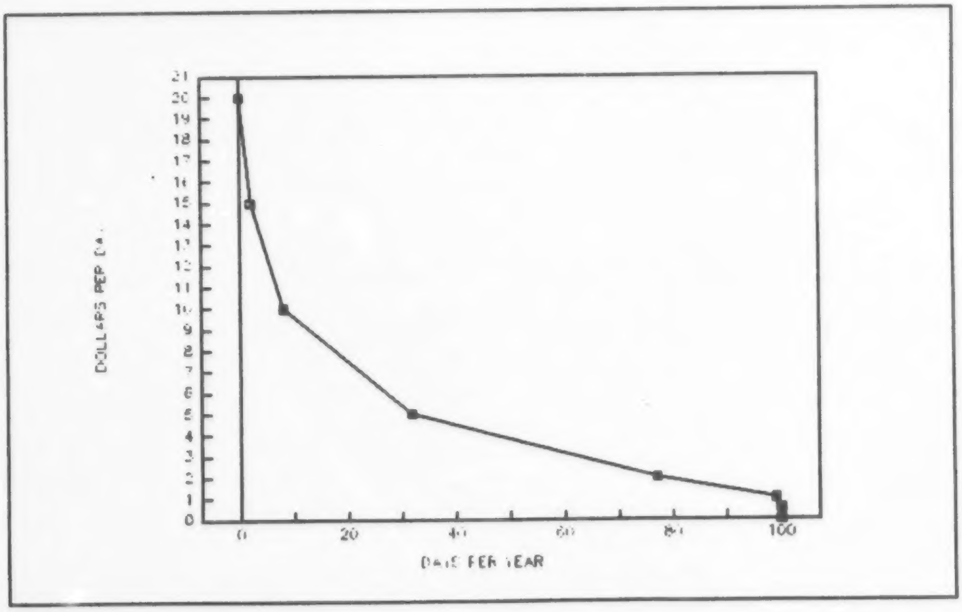


Figure 7

DEMAND CURVE FOR WETLAND RECREATION IN THE STUDY AREAS BY SURVEY HOUSEHOLDS IN THE KING GEORGE STUDY AREA (Sample Size = 9)

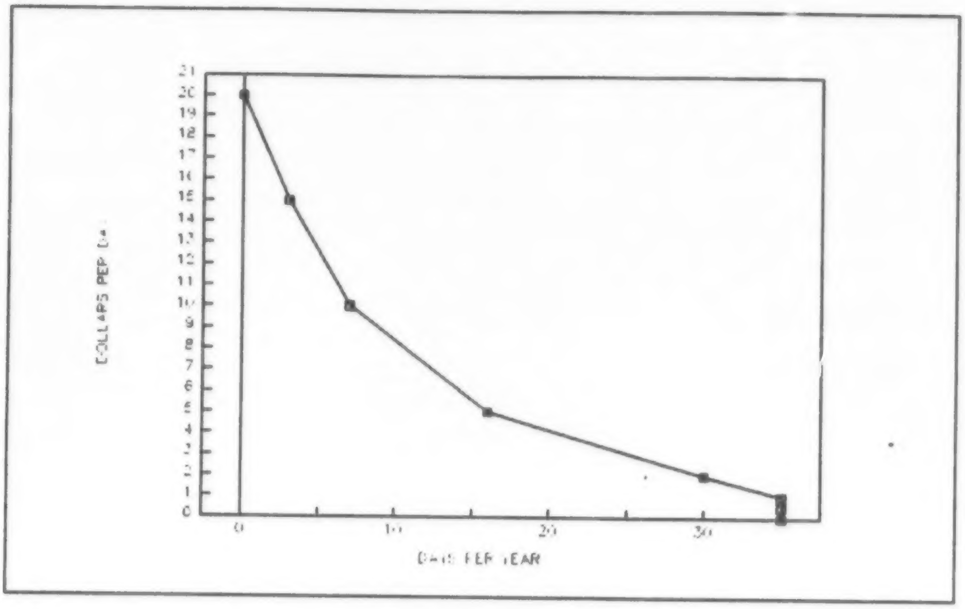
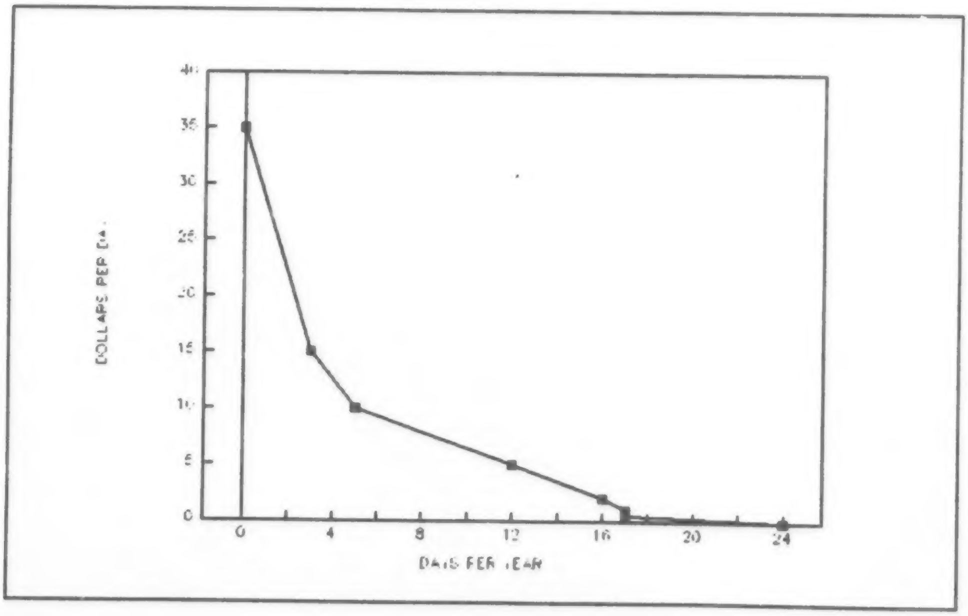


Figure 8

DEMAND CURVE FOR WETLAND RECREATION IN THE STUDY AREAS BY SURVEY HOUSEHOLDS IN SOUTHERN SASKATCHEWAN (Sample Size = 12)



When this information on average values is combined with the estimates of annual use, the total benefits derived from wetland recreation by residents of southern Saskatchewan is on the order of $14.7 million (± 0.6 million). For residents of the Lost River and King George regions, these benefits are substantially smaller ($0.5 million and $0.2 million, respectively) and, due to the smaller sample sizes and higher variability in use characteristics are much less reliable (± $0.3 million and ± 0.2 million, respectively).

For wetland recreation in the two Study Areas, a slightly different valuation question was employed. This question attempted to determine what people would be willing to pay for wetland recreation in either of the two Study Areas considering that other wetland areas would be free of charge. The purpose of structuring the question in this manner is to determine the extent to which wetlands in the Study Areas are more (or less) valuable for recreation than wetlands in the surrounding areas.

The results from this question are also summarized in Table 18. According to the survey results, recreation in the study area wetlands is more valuable than in the surrounding areas by about $6.40 per user-day in the case of people from southern Saskatchewan. For regional residents, who don't have to travel so far to reach wetlands in the Study Areas, the incremental value of recreation is even larger: $9.30 for residents of the Lost River area and $8.40 for people in the King George area. It should be noted, however, that the level of accuracy in these results is very poor (at best ± 50 percent) because of the smaller sample sizes on which this information is based. Again, the median values were all smaller than the average values, with the differences being most significant for the two Study Areas.

Interpretation of these results requires some caution for a number of reasons. According to the survey design, the value of recreational opportunities in the study area wetlands for residents of southern Saskatchewan should be about $11.60 per user-day, based on a value of $5.20 for wetlands in general plus a $6.40 surcharge for the study area wetlands. The corresponding calculations suggest values of $15.60 and $13.00 per user-day for residents of the Lost River and King George areas, respectively.

However, it is possible that minor variations in the wording of the question may have gone unnoticed by the majority of survey respondents with the result that the regional estimates are directly comparable to the estimates for wetlands in general. In this case, residents of southern Saskatchewan would appear to consider wetlands in the study area ($6.40 per user-day) to be marginally more valuable than other wetland areas in the province ($5.00 per user-day). In comparison, regional residents place a higher value on local wetlands by between $3.00 and $3.80 per day. In making these comparisons, however, the observed differences are not statistically significant.

On the assumption that value estimates for recreation in the study area wetlands are average value, rather than marginal values, the total value of recreational benefits generated by these wetlands is about $0.5 million. This represents about three percent of the $14.7 million estimated for wetland areas in total.

Caution in interpreting the results in Table 18 is also necessitated by the high variability in the estimates of recreational benefits for wetlands in the study area. This variability is due to a compounding of all the variation associated with the multiple parameters used to calculate total benefits, not just the variability in the average daily values. Clearly, a much greater sampling program would be required to establish value estimates that are reliable enough to support policy decisions. However, with no other sources of data on the recreational value of wetlands, the remainder of this pilot study is based on the value estimates contained in Table 18.

One additional indicator of the importance of wetlands pertains to the amount that people are willing to spend on travel, accommodation, food, equipment and other items in order to participate in wetland recreation. While this aspect of value was not addressed during the survey, estimates of these expenditures are available from other sources. As detailed in Table 19, Saskatchewan residents who participated in hunting or went on trips related to non-consumptive use of wildlife spent about $40 and $36 per day, respectively. Use of these estimates would suggest that, in order to participate in wetland recreation, residents of southern Saskatchewan spent about $138.0 million during the 12 months preceding the survey. For wetland recreation in the two Study Areas, total expenditures amounted to about $4.2 million.

4.2.3 Other Consumptive Values

To this point in the analysis, only the benefits to direct users of the study area wetlands have been examined. There are other indirect types of benefit that must also be addressed. One of these indirect types of benefit is that much of the migratory wildlife produced by these wetlands, especially waterfowl, benefit people living outside the region and especially outside the province. For the prairie pothole wetlands, these extra-provincial benefits are expected to be considerable given the waterfowl productivity of these wetland areas. While there are no data with which to assess non-consumptive use of wildlife from wetlands in the study area, it is possible to estimate the benefits attributable to waterfowl hunting.

Table 20 provides a summary of the production of Mallard ducks in Saskatchewan over the period from 1972 to 1982. The data suggest an average net production of about 1.6 million per year of which about 67 percent are "exported" to the United States during fall migration. Thus, only about 23 percent of the Saskatchewan Mallard duck population is actually harvested within the province. In addition, Mallards were found to comprise about 70 percent of the annual Saskatchewan harvest.

TABLE 19

AVERAGE EXPENDITURES ASSOCIATED WITH WILDLIFE UTILIZATION BY RESIDENTS OF SASKATCHEWAN

	Saskatchewan		Canada	
	1981	1987	1981	1987
Primary Non-Consumptive Trips:				
Per Day	$ 45	$ 36	$ 37	$ 30
Per Year	$715	$579	$589	$507
Hunting				
Per Day	$ 32	$ 40	$ 37	$ 37
Per Year	$508	$522	$662	$630

Source: Environment Canada (1983). The Importance of Wildlife to Canadians in 1981: Highlights of a National Survey. Canadian Wildlife Service.
Environment Canada (1989b). The Importance of Wildlife to Canadians in 1987: Highlights of a National Survey. Federal Provincial Task Force for the 1987 National Survey on the Importance of Wildlife to Canadians.

TABLE 20

MALLARD PRODUCTION IN SASKATCHEWAN

	Net Production	Net Export	Saskatchewan Harvest
1972	1 603	1 077	526
1973	1 522	1 172	381
1974	1 907	1 370	537
1975	2 415	1 855	561
1976	2 729	2 047	682
1977	1 615	1 175	432
1978	1 120	690	423
1979	1 644	1 171	464
1980	901	526	378
1981	659	659	255
1982	716	458	258
Average	1 567	1 047	427

Source: Cooch, F.G. and H. Boyd (1984). Changes in the Net Export of Mallards From Western Canada and the Contiguous United States 1972 - 1982. Canadian Wildlife Service program Report No. 142.

For other duck species, the proportion exported to the United States is even greater because they tend to migrate earlier in the year before the duck hunting season opens in Canada. Harvest information provided by Anderson (1984) for Alberta suggests that duck species other than Mallards account for only 32 percent of the Alberta harvest, yet comprise 78 percent of fall flights. In terms of total harvest, Anderson provides the following estimates for Alberta produced ducks:

	Mallards	Others	Total
Harvested in Alberta	15.4%	1.9%	4.8%
Harvested in the U.S.	26.9%	40.4%	37.5%
Total Harvest	42.3%	42.3%	42.3%

Thus, for every 100 ducks produced in Alberta, 42 are harvested and 37 of these are harvested in the United States. The U.S. portion therefore represents about 89 percent of the total harvest of all ducks and about 64 percent of the total Mallard harvest.

Anderson's study also examined the distribution of hunter effort and economic benefits generated by Alberta-produced ducks. His estimates show that about 85 percent of hunter-days induced by Alberta-produced ducks and, correspondingly, 85 percent of hunter benefits, including licence fee revenues and non-market benefits, accrue to hunters in the United States. This split is similar to the distribution of costs for implementation of the North American Waterfowl Management Plan which is being 75 percent funded by the United States.

Unfortunately, there is no corresponding data for Saskatchewan regarding the distribution of hunter effort, harvest and economic benefits for provincially-produced waterfowl. In the absence of such information, it has therefore been assumed that the overall pattern of harvest for Saskatchewan-produced ducks is the same as shown for Alberta. Thus, about 89 percent of the annual harvest of ducks produced by prairie pothole wetlands in Saskatchewan are assumed to be taken by hunters in the United States and this group enjoys about 85 percent of the economic benefits flowing from the annual harvest. This distribution of benefits throughout North America is consistent with the findings of a similar study conducted in 1986 (Adamowicz *et al.*, 1986).

Although the exact number of ducks produced by the prairie pothole wetlands within the two Study Areas is not known, a crude estimate can be formulated. This estimate is based on an average density of 155.33 ducks per square mile or 0.60 ducks per ha (0.24 ducks per acre) for Stratum 32[11]. Accordingly, an estimate of the total number of ducks and the estimated harvest that can be attributed to wetlands in each of the two Study Areas is as follows:

	Lost River Study Area	King George Study Area	Total
Total Area (ha)	57 072	84 484	141 556
Total ducks	33 830	50 080	83 910
Total harvest	14 310	21 180	35 490
Saskatchewan harvest	1 570	2 330	3 900
U.S. harvest	12 740	18 850	31 590

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[11] Personal communication, A. Didiuk. Estimates are based on unpublished data from the Canadian Wildlife Service for the period from 1970 to 1989. Assumes 1.08 fledged young per adult bird.

The amount of hunting supported by this level of harvest is estimated to be about 3 075 hunter-days in Saskatchewan, with 1 240 hunter-days attributable to wetlands in the Lost River Study Area and 1 835 hunter-days from wetlands in the King George Study Area[12].

To estimate the average benefits that people derive from hunting waterfowl, two sources of information are available. Both are based on estimates of hunters' willingness-to-pay to hunt waterfowl over and above the costs of transportation and other expenses. Estimates generated from the 1981 study on the value of wildlife to Canadians (Jacquemot *et al.*, 1986) shows that the direct benefits to waterfowl hunters in Saskatchewan were about $152 per hunter per year. With the average hunter spending about six or seven days hunting during the year, this represents an average daily benefit of $22 to $25. When inflated to 1990 dollars, this benefit is equivalent to $33 to $37. The second study, undertaken in Alberta in 1975 (Phillips *et al.*, 1977), showed the average waterfowl hunter was willing to pay about $22 per day. In 1990 dollar equivalents, this would be equal to about $47 per day.

Using an estimate of $40 per hunter-day as a crude approximation of these non-market benefits, the value of waterfowl hunting in Saskatchewan attributable to ducks produced by the pothole wetlands in the two Study Areas is estimated to be about $123 000 per year. This estimate is again based on the average value of a day of hunting for typical hunting conditions and is of limited use in assessing how a change in the number or size of wetlands and associated duck populations will affect hunter success and the associated non-market benefits. Unfortunately, there is insufficient information to be able to gauge the marginal values associated with wetland drainage in the Study Areas.

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[12] These estimates assume a hunter success rate of 1.27 ducks per hunter-day, as per data in Metras and Wendt (1986).

For U.S. hunters, the equivalent benefits would be approximately $697 000, assuming (as noted above) that they account for 85 percent of the total benefits. This estimate is somewhat arbitrary, but is not unreasonable. One study conducted in the U.S. in 1968-69 (Hammack and Brown, 1974) identified the average value of waterfowl hunting to be about $25 per day, and in current Canadian dollars, this would be much higher than the $40 per day assumed in this analysis. However, there are probably some important differences in actual hunting costs and hunting quality that make direct comparison of non-market benefits for Canadian and U.S. hunters quite difficult. In the absence of more reliable data, this simplistic approach for measuring benefits to U.S. hunters will suffice for the purposes of this pilot study. It must be remembered, however, that these average values are of limited use in estimating the change in U.S. hunting benefits that would occur as a result of wetland development in the Study Areas.

Overall, wetland benefits attributable to the Study Areas in the form of hunting opportunities are estimated to have a total annual value of about $820 000. Of this, wetlands in the Lost River Study Area contribute about $330 700 in benefits compared to $489 300 for the King George Study Area. Given the extent of non-saline wetlands in each of the Study Areas (see tables 3 and 4), these benefits are equivalent to about $103 per hectare of wetland in the Lost River Study Area and $123 per hectare in the King George Study Area.

4.2.4 Existence or Preservation Values

Another form of indirect benefit that can be attributed to wetlands relates to option or preservation values. For some people, just the knowledge that wetlands are there for them or their children to use at some time in the future represents a type of benefit. These existence or preservation values are real, but defy ready quantification.

Some insight into the nature of these values can be gained by considering people's attitudes toward wetlands. In the survey, for example, respondents were asked to rate the importance of conserving wetland areas in Saskatchewan using a five-point scale. The results, shown in Table 21, show few differences among the various reference groups. In all cases, at least 56 percent of people interviewed rated wetland protection as being very important. The data also show that similar types of ratings were given regardless of whether or not people actually used wetlands.

Another question related to wetland values asked people about the balance between wetlands and agricultural land: should the current balance be maintained, should continued agricultural development on wetlands be allowed, or should actions that would protect and reclaim wetlands be encouraged?

Responses to this question are provided in Table 22. For all three survey groups, the majority of people (59 percent or more) felt that conservation and reclamation of wetlands should be encouraged while fewer than 10 percent were in favour of continued agricultural development on wetlands. Of the three survey groups, people in the Lost River study area were least committed to wetland conservation.

Table 22 also shows some interesting differences in attitudes about the balance between wetlands and agriculture based on whether people used wetlands for recreational purposes and the urban/rural setting in which they lived. From the survey of households in southern Saskatchewan, households that use wetlands are more in favour of encouraging wetland protection and preservation (77 percent) than are households that do not use wetlands (63 percent). In terms of where people live, the results show that it is the rural community, especially the rural non-farm community, that is most in favour of encouraging wetland conservation and preservation.

TABLE 21

IMPORTANCE OF PROTECTING WETLAND AREAS IN SASKATCHEWAN

Households Residing In	Very Important			Not Important	
	5	4	3	2	1
Lost River Study Area:					
Wetland Users	62.5	25.0	10.4	0.0	2.1
Wetland Non-Users	50.0	30.8	11.5	1.9	5.8
Total Sample	56.0	28.0	11.0	1.0	4.0
King George Study Area:					
Wetland Users	72.2	25.0	2.8	0.0	0.0
Wetland Non-Users	60.3	25.4	11.1	0.0	3.2
Total Sample	64.6	25.3	8.1	0.0	2.0
Southern Saskatchewan:					
Wetland Users	61.7	24.7	7.4	3.7	2.5
Wetland Non-Users	54.1	24.5	18.9	1.9	0.6
Total Sample	57.0	24.4	14.9	2.5	1.2

TABLE 22

FUTURE ACTION ON WETLANDS AND AGRICULTURE
(Percent of Respondents)

Households Residing In:	Continued Agricultural Development	Maintain Current Balance	Protect and Reclaim Wetlands
Lost River Study Area	10.0	31.0	59.0
Wetland Users	6.3	18.8	75.0
Non-Users	13.5	42.3	44.2
Urban	14.3	16.7	69.0
Rural Farm	4.3	48.9	46.8
Rural Non-farm	18.2	9.1	72.7
King George Study Area	2.0	36.7	61.2
Wetland Users	0.0	29.7	70.3
Non-Users	3.3	41.0	55.7
Urban	0.0	40.7	59.3
Rural Farm	6.3	28.1	65.6
Rural Non-farm	0.0	42.9	57.1
Southern Saskatchewan	3.3	28.8	67.9
Wetland Users	3.7	19.8	76.5
Non-Users	3.2	33.5	63.3
Urban	4.0	30.3	65.7
Rural Farm	0.0	24.2	75.8
Rural Non-farm	0.0	10.0	90.0

Within the two Study Areas, a similar pattern of preferences is shown, with wetland users being more interested in wetland preservation and protection than people who do not use wetlands. However, in the Lost River Study Areas, the people living in an urban setting were much more interested in wetland conservation than was the rural farm population, nearly half of whom were interested in maintaining the existing balance between agriculture and wetlands. In the King George Study Area, these positions switched, with the rural farm community being more interested in wetland conservation and preservation than the other two groups.

Measurement of these existence or preservation values has been done on a limited basis and the resulting surveys have typically produced poor results. Rather than measure these values directly, it was decided that some indication of the relative importance of these values could be determined through asking people about their willingness-to-pay into an annual fund that would be devoted to wetland conservation and preservation in Saskatchewan. The survey provided no details about how such a fund would actually be used for wetland conservation and, consequently, survey responses may reflect a different concept of what such a fund would entail. While this uncertainty may limit the usefulness of this approach to measuring existence values, the results nevertheless provide a useful insight into how people perceive the importance of wetlands.

Of southern Saskatchewan households, it was determined that about 42 percent would be willing to pay into such a fund, with the average annual payment being about $42 per year (refer to Table 23), although the most common response was $10 per year and the median response was $25 per year. For the 372 200 households in this area, survey responses suggest that annual donations into such a fund would be on the order of about $6.5 million based on the average willingness-to-pay or $3.9 million based on the median value. This would be equivalent to between 27 and 44 percent of the $14.7 million that recreationists would be willing to pay to use wetlands each year (see Table 17).

TABLE 23

WILLINGNESS TO PAY INTO A WETLAND CONSERVATION AND PRESERVATION FUND

	Would Pay				
Households Residing In:	No	Yes	Average	95% C.I.	Median Value
	%	%	$	± $	$
Lost River Study Area	43.8	56.2	53.82	20.88	32.50
Wetland Users	26.7	73.3	69.42	30.17	50.00
Non-Users	61.4	38.6	23.53	7.78	20.00
Urban	34.2	65.8	42.20	14.19	30.00
Rural Farm	46.2	53.8	78.39	53.20	50.00
Rural Non-farm	22.2	77.8	32.14	18.25	25.00
King George Study Area	48.5	51.5	41.85	13.83	25.00
Wetland Users	44.8	55.2	47.13	25.25	22.50
Non-Users	58.6	41.4	38.33	16.05	25.00
Urban	51.9	48.1	36.20	16.02	20.00
Rural Farm	59.3	40.7	55.36	34.22	25.00
Rural Non-farm	50.0	50.0	40.00	19.60	50.00
Southern Saskatchewan	58.1	41.9	41.76	8.94	25.00
Wetland Users	54.5	45.5	44.06	16.48	20.00
Non-Users	59.5	40.5	39.84	10.64	25.00
Urban	59.1	40.9	35.43	8.99	20.00
Rural Farm	51.6	48.4	54.33	16.53	50.00
Rural Non-farm	50.0	50.0	104.00	79.10	75.00

Again, there is some variation in survey responses according to the urban/rural setting in which people live and whether or not they actually use wetlands. Urban dwellers were less likely than people living on farms to pay into such a fund, and the average donations would be less (about $35 compared to $54 per year for households in the farm community). Wetland users were also more likely to contribute to such a fund and were willing to contribute more than non-users of wetlands. Similar trends can also be observed by comparing median values.

A similar pattern of attitudes emerges from the regional responses, although much more variation was evident in the results for the Lost River Study Area. In this area, wetland users were twice as willing to contribute than non-users, and the annual amounts were three times as large. And, while members of the farm community were less likely than urban dwellers to make contributions, the average amount of contribution was nearly twice as large.

It should be noted that all three respondent groups indicated a preference for nature groups to control such a wetland conservation fund. At a provincial level, a preference was shown for Ducks Unlimited Canada while, at the regional level, the Saskatchewan Wildlife Federation was preferred (refer to Table 24). If government control of a wetland conservation and preservation fund was suggested, the provincial government was preferred over local government which was, in turn, given preference over federal government involvement.

Various reasons for not wanting to contribute to a wetland conservation/preservation fund were given. The most significant of these were as follows:

TABLE 24

WHO SHOULD CONTROL THE WETLAND PRESERVATION/PROTECTION FUND?

(Percent of Responses)

Households Residing In:	Lost River Study Area	King George Study Area	Southern Saskatchewan
Nature Organizations	38.2	40.3	44.7
Wildlife Federation	45.8	57.1	33.3
Ducks Unlimited Canada	41.7	38.1	36.7
World Wildlife Fund	4.2	0.0	5.0
Wildlife Habitat Canada	4.2	4.8	0.0
Other	4.2	0.0	0.0
Don't Know	0.0	0.0	25.0
Sub-total	100.0	100.0	100.0
Provincial Government	23.5	35.1	30.4
Local Government	22.1	19.3	15.5
Federal Government	8.8	5.3	8.1
All\Mix of the Above	7.4	0.0	1.2
TOTAL	100.0	100.0	100.0

Households Residing In	Lost River Study Area	King George Study Area	Southern Saskatchewan
Can't afford to	48.7%	51.5%	43.8%
Government responsibility	17.9%	6.4%	13.9%
Already donates to similar causes	5.1%	4.2%	11.0%
More worthwhile causes	2.6%	4.3%	2.2%
Unsure money will be properly used	7.7%	2.1%	1.5%
Enough wetland around	2.6%	4.3%	0.7%
Other reasons	15.4%	27.2%	26.9%

Thus, economic concerns rather than disagreement with the concept of wetland conservation/protection appear to be the most common factors that would limit contributions to a wetland fund.

4.3 OTHER VALUES

Potential hydrological benefits associated with wetlands include functions such as headwater storage to attenuate the effects of major runoff events, groundwater recharge (Meyboom, 1966; Lissey, 1971) and enhancement of soil moisture conditions. As neither study area has watercourses, the criterion of headwater storage was eliminated from the hydrological assessment of wetland functions in the Study Areas. Consequently, the rating of study area wetlands with regard to hydrological considerations is based on capabilities for groundwater recharge and soil moisture enhancement.

As was the case with the recreational evaluation, the Study Areas should be more appropriately evaluated as a whole rather than on the basis of wetland type. Individual wetland types are, nonetheless, also evaluated, with semi-permanent and permanent wetlands assigned greater importance given that they provide a source of water for soil moisture enhancement and groundwater recharge throughout the year (Table 25). A second assumption is that the two Study Areas also lie in a groundwater recharge area (Christiansen *et al.*, 1969). Contrary to the previous two wetland function rating calculations, the groundwater and soil moisture ratings were added as the capability of the individual wetland types to provide those benefits was not as pronounced as was the product of the capability and scarcity assessments. As Table 25 illustrates, both Study Areas have similar ratings with regard to hydrological considerations.

From the perspective of water quality, wetlands can enhance water quality by capturing and assimilating wastes, including agricultural products before releasing waters into receiving watercourses (Lakshman, 1979; O'Keefe *et al.*, 1987; Reddy and Smith, 1987). Furthermore, they also capture soils that are transported off fields during run-off, thereby reducing siltation of receiving watercourses. Wetlands containing plant species such as cattail and bulrush with substantial root mass are considered preferable for assimilating wastes in water (Lakshman, 1979). A second important criterion in waste assimilation is the amount of time contaminants can be retained in a wetland (Ferguson *et al.*, 1989).

With regard to assigning a total capability rating to the various wetland types, the biomass and retention criteria ratings were added, rather than multiplied. As Ferguson *et al.* (1989) suggested, this approach assumed that differences in wetland types are less pronounced than for other wetland functions. Authors of the document also feel that addition rather than multiplication is more appropriate given that a particular wetland type can generally provide both the preferred vegetation and water retention.

TABLE 25

RATING OF WETLANDS IN THE PRAIRIE POTHOLE WETLANDS STUDY AREAS IN TERMS OF HYDROLOGY

Study Area Wetland Type	Groundwater Rating	Soil Moisture Rating	Total Rating
Lost River Study Area			
Temporary/Seasonal	3	3	6
Semi-permanent	5	5	10
Permanent	5	5	10
Saline	1	2	2
Total Study Area	3	1	6
King George Study Area			
Temporary/Seasonal	3	3	6
Semi-permanent	5	5	10
Permanent	5	5	10
Saline	1	1	2
Total Study Area	3	3	6

Rating Scale: Capability
5 = high
3 = medium
1 = low

Groundwater Recharge Rating = Duration of time for groundwater recharge opportunity.

Soil Moisture Enhancement = Duration of time for soil moisture enhancement opportunity.

There was no difference in capability between Study Areas. With regard to wetland types, semi-permanent and permanent wetlands were best in terms of presence of preferred plant species and long retention times (Table 26). It should be noted that, in this instance, the water quality evaluation is theoretical because the wetlands in the Study Areas do not discharge waters into receiving watercourses.

4.4 SUMMARY

There are two major conclusions to be drawn from the preceding analysis. First, from the perspective of all wetland functions examined, it is evident that permanent pothole wetlands contribute more in terms of wildlife habitat, recreation, hydrology and water quality that do the other three types of wetland types. As shown in Table 27, this conclusion applies to wetlands in each of the two Study Areas.

The results also suggest that semi-permanent wetlands are second in terms of their ability to perform various wetland functions, having slightly higher ratings than temporary/seasonal wetlands in all functions other than wildlife habitat. Saline wetlands are shown to have relatively low abilities to perform all manner of the wetland functions.

The second conclusion relates to the value of benefits contributed by wetlands in the study area. While study area wetlands provide a broad range of benefits, lack of data has prevented full investigation and documentation of most of these benefits. Quantification of benefits has been restricted to a number of recreational functions served by wetlands because data could readily be obtained and a recognized evaluation procedure could be employed. Thus, the resulting estimates provide only a partial assessment of the benefits of wetlands in the Study Areas.

As detailed in Table 28, four types of recreational benefits were identified. These included:

TABLE 26

RATING OF WETLANDS IN THE PRAIRIE POTHOLE WETLANDS STUDY AREAS IN TERMS OF WATER QUALITY

Study Area Wetland Type	Groundwater Rating	Soil Moisture Rating	Total Rating
Lost River Study Area			
Temporary/Seasonal	3	3	6
Semi-permanent	5	5	10
Permanent	5	5	10
Saline	1	1	2
King George Study Area			
Temporary/Seasonal	3	3	6
Semi-permanent	5	5	10
Permanent	5	5	10
Saline	1	1	2

Rating Scale: 5 = high
3 = medium
1 = low

Productivity Rating = relative amount of below ground biomass.

Water Retention Rating = relative contact time between ambient water and vegetation.

TABLE 27

SUMMARY OF WETLAND RATINGS

Study Area Wetland Type	Wildlife Habitat	Recreation	Hydrology	Water Quality
Lost River Study Area				
Temporary/Seasonal	5	3	6	6
Semi-permanent	5	5	10	10
Permanent	15	15	10	10
Saline	1	1	2	2
King George Study Area				
Temporary/Seasonal	5	3	6	6
Semi-permanent	5	5	10	10
Permanent	15	15	10	10
Saline	1	1	2	2

TABLE 28

SUMMARY OF RECREATIONAL BENEFITS ATTRIBUTABLE TO STUDY AREA WETLANDS

(1990 Dollars)

	Lost River Study Area	King George Study Area	Combined Areas
Benefits to Saskatchewan Residents:			
Hunting	$49 600	$73 400	$123 000
Other	117 600	261 800	379 400
Existence	51 700	169 400	221 100
Sub-total	$218 900	$504 600	$723 500
Benefits to U.S.:			
Hunting	$281 100	$415 900	$697 000
Total Benefits	**$500 000**	**$420 500**	**$1 420 500**
Extent of Wetland Area (ha)			
Total	5 700	5 689	11 389
Non-Saline	3 200	3 697	6 897
Benefit Per Hectare:			
Saskatchewan	$68.40	$136.50	$104.90
U.S.	87.80	112.50	101.10
Total	$156.20	$249.00	$205.96

- waterfowl hunting for residents of Saskatchewan. Based on waterfowl productivity at wetlands in both Study Areas, this was estimated to be about 3 075 hunter-days and represented about $123 000 in annual benefits, based on an average willingness-to-pay for recreation of about $40 per hunter-day. As willingness-to-sell is the more appropriate method for quantifying these benefits, the real benefits of resident hunting may be double this amount[13];

- waterfowl hunting for residents of the United States who are assumed to account for about 85 percent of the benefits from waterfowl production in Saskatchewan or about $697 000 per year. Given the uncertainties in measuring these values, including a lack of information about the actual distribution of hunting benefits and the values associated with these benefits, actual benefits could be twice this amount (see above). Other non-consumptive uses of migratory birds produced by study area wetlands also occur in the U.S., but there are no data with which to measure the amount of this use or the associated benefits.

- recreational activities, other than hunting, enjoyed by residents of southern Saskatchewan. As shown in Table 12, about 83 percent of wetland recreation consisted of a viewing scenery, hiking, walking and other activities and total use is therefore estimated to be about 92 000 visitor-days. The measure of benefit for these activities amounted to about $379 400 based on 83 percent of total recreational values. Survey results also showed that, for residents of southern Saskatchewan, about 31 percent of activity occurred in the Lost

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[13] This observation was confirmed by Jack Knetsch at the "Wetlands Are Not Wastelands" workshop in Ottawa in January of 1990 and was confirmed in a recent journal article (Knetsch, 1990). Due to difficulties in measuring willingness-to-sell values for recreation, the alternative evaluation method based on willingness-to-pay was adopted with the understanding that the resulting values would be at least half of the willingness-to-sell measure of benefit.

River Study Area with the remainder in the King George Study Area. It is assumed that hunting activities in these wetland areas have been addressed in the first category of recreational benefit.

- the preservation benefits that provincial residents derive from knowing that wetlands exist or are there to use if they so desire. The estimate of value is based on the earlier observation that the average annual amount that Saskatchewan households would be willing to pay into a wetland preservation fund was equivalent to about 44 percent of the benefits derived directly from wetland recreation. This was estimated to be about $221 100 but is considered to be a very conservative estimate.

In summary, the results suggest that the value of benefits derived from some of the most obvious recreational activities related to the direct use of wetlands in the Study Area amounted to at least $1.4 million per year. On the assumption that saline wetlands contribute very little of these benefits and given the extent of non-saline wetlands in each of the Study Areas, these recreational benefits amount to at least $206 per hectare ($83 per acre). This estimate ranges from $156 per hectare ($63 per acre) in the Lost River Study Area to $249 per hectare ($101 per acre) in the King George Study Area. For Saskatchewan residents alone, the corresponding estimates range between $68 and $136 per hectare ($28 to $55 per acre), with an average of about $105 ($42 per acre).

It must be remembered that these conclusions are based on highly variable survey results and numerous simplifying assumptions, and that only some aspects of the recreational attributes of study area wetlands have been quantified. While more research would provide more reliable estimates of these values, the results of this pilot study demonstrate the approximate magnitude of some of the benefits that can be derived from maintaining and conserving wetlands. Considering that only some types of benefits have been addressed and that the evaluation methodology tends to underestimate values, it can be concluded that the real value of wetlands in the study area is greater than the amounts shown in Table 28.

5.0 ALTERNATIVE USE OF WETLANDS: AGRICULTURE

5.1 INTRODUCTION

Unlike some of the other Pilot Project Study Areas, development in the Prairie Pothole Study Areas is essentially restricted to expansion of agricultural activities. Destruction of wetland habitat for purposes of agricultural development can result from several different practices:

- elimination (by drainage) of the myriad of wetlands that form impediments to machinery operations and which delay seeding operations because of the presence of water in fields during spring.

- cultivation of wetlands and their margins during drought conditions can destroy the integrity of wetland vegetation for use by nesting ducks and by breeding waterfowl in the subsequent year should the dry basin happen to re-fill; and,

- expansion of cultivation into pasture lands, while it does not directly impact wetlands, does impact upon migratory birds, including certain duck species, that depend upon the grasses and shrubs in pasture areas for nesting habitat. Once these lands are cultivated, erosion from these often-marginal lands can also negatively affect these wetlands because of the introduction of fertilizers and pesticides (Young, 1989).

A number of investigators have described how wetland habitat has experienced a substantial decline since the advent of agricultural activity in Prairie Canada (Goodman and Pryor, 1972; Lynch-Stewart, 1983; Rakowski and Chabot, 1983; Brace and Pepper, 1984; Turner *et al.*, 1987; Young, 1989). For example, Turner *et al.* (1987) suggest that approximately 40 percent of Prairie Canada wetlands have been lost during this time. Turner *et al.* (1987) also reported that, during the period 1981-1985 alone, an average of 59 percent and 78 percent of Saskatchewan's wetland basins and margins, respectively, were altered by agriculture activity on an annual basis. The Grassland portions of the Prairies, such as those contained by the Study Areas, were impacted at even higher rates, 63 percent and 85 percent (*op. cit.*).

More specific to the Study Areas, the Tichfield and Hanley transects, as developed by the Canadian Wildlife Service, lie within the Study Areas. Wetlands along these transects have been surveyed during the years 1981-1988 to assess changes in wetland basins and their margins (see Turner *et al.*, 1987). By 1989, 72.3 percent of the wetland basins and 87.5 percent of the wetland margins along the Tichfield transect had been adversely affected by agricultural activities which included drainage, cultivation and burning (Canadian Wildlife Service, unpublished data and personal communications, A. Didiuk). The Hanley transect also revealed wetland data provided in tables 29 and 30. These tables show the number and size of wetlands that would be located on a typical 1.5-section farm (389 ha) in the Lost River and King George Study Areas. The data have been estimated by counting and measuring wetland areas in typical townships in each of the two Study Areas, as described in the map information provided in appendices II and III.

For the Lost River Study Area, the amount of wetland area is highly variable in terms of both number and percent of land area covered. In general, land used for agricultural purposes tends to have numerous but smaller wetlands when compared to pasture land. In agricultural areas having low densities of wetlands, wetlands appear to account for about six percent of the land area, but this proportion increases to about 11 percent for areas with high densities of wetlands. Typically these wetlands are small (0.58 hectares or 1.4 acres) and range in number from 29 to 85 per 1.5-section farm. Only about one percent of wetlands on agricultural lands are classed as permanent wetlands. Nearly half (49 percent) are seasonal/temporary

TABLE 29
TYPICAL WETLAND CONFIGURATIONS PER 1.5 SECTIONS OF LAND: RURAL MUNICIPALITY OF LOST RIVER

	Wetland Type				
Land Use & Wetland Density	Seasonal/Temporary	Semi-Permanent	Permanent	Saline	Total
Agricultural Land					
Low Density Wetlands					
Number of wetlands	16.6	3.8	0.2	8.6	29.2
Wetland Area (ha)	9.09	5.09	0.21	8.78	23.17
Percent	2.3	1.3	0.1	2.2	5.9
Medium Density Wetlands					
Number of Wetlands	22.5	12.9	0.2	9.8	45.4
Wetland Area (ha)	8.84	9.91	0.59	6.00	25.34
Percent	2.2	2.5	0.1	1.5	6.4
High Density Wetlands					
Number of wetlands	37.9	17.7	1.5	27.9	85.0
Wetland Area (ha)	11.26	10.55	4.59	18.21	44.61
Percent	2.8	2.7	1.2	4.6	11.3
Pasture Lands					
Low Density Wetlands					
Number of wetlands	13.2	7.1	0.3	5.1	25.7
Wetland Area (ha)	14.85	4.90	0.54	16.13	36.42
Percent	3.8	1.2	0.1	4.1	9.2
Medium Density Wetlands					
Number of wetlands	35.8	16.9	1.2	19.7	73.6
Wetland Area (ha)	24.67	25.82	1.97	24.87	77.33
Percent	6.2	6.5	0.5	6.3	19.6
High Density Wetlands					
Number of wetlands	49.2	12.6	1.0	32.7	95.5
Wetland Area (ha)	11.85	10.72	1.82	27.70	52.09
Percent	3.0	2.7	0.5	7.0	13.2

TABLE 30
TYPICAL WETLAND CONFIGURATIONS PER 1.5 SECTIONS OF LAND: RURAL MUNICIPALITY OF KING GEORGE

	Wetland Type				
Land Use & Wetland Density	Seasonal/Temporary	Semi-Permanent	Permanent	Saline	Total
Agricultural Land					
Low Density Wetlands					
Number of wetlands	3.3	0.5	0.5	2.7	7.0
Wetland Area (ha)	1.63	0.42	0.01	2.48	4.54
Percent	0.4	0.1	0.0	0.6	1.2
Medium Density Wetlands					
Number of Wetlands	16.0	7.9	0.7	4.6	29.2
Wetland Area (ha)	7.03	8.87	1.36	3.70	20.96
Percent	1.8	2.2	0.3	0.9	5.3
High Density Wetlands					
Number of wetlands	29.5	14.7	2.2	2.2	48.6
Wetland Area (ha)	9.41	11.30	3.29	3.31	27.31
Percent	2.4	2.9	0.8	0.8	6.9
Pasture Lands					
Low Density Wetlands					
number of wetlands	12.2	1.5	0.5	3.5	17.6
Wetland Area (ha)	3.65	0.47	0.09	3.95	8.16
Percent	0.9	0.1	0.0	1.0	2.1
Medium Density Wetlands					
Number of wetlands	22.4	3.1	1.1	5.1	31.7
Wetland Area (ha)	8.04	4.43	2.02	14.76	29.25
Percent	2.0	1.1	0.5	3.7	7.4
High Density Wetlands					
Number of wetlands	33.4	10.1	1.7	6.3	51.5
Wetland Area (ha)	11.99	13.66	2.82	23.51	51.98
Percent	3.0	3.5	0.7	6.0	13.2

wetlands, about 29 percent are saline and the remainder (21 percent) are semi-permanent.

Wetlands on land used for pasture tend to be larger (0.85 hectares or 2.1 acres) and slightly more numerous (from 26 to 96 per 1.5-section farm). However, the types of wetlands are quite similar, with half being seasonal/temporary, one percent being permanent wetlands and about 30 percent being saline.

The wetland characteristics for the King George Study Area (Table 30) are a little different: there are fewer wetland areas, but they tend to be larger in size. On agricultural lands, for example, there are from seven to 49 wetlands with the average size being about 0.62 hectares (1.5 acres). While a slightly greater percentage of wetlands in agricultural areas are permanent (four percent), there are less saline wetlands (12 percent). As in the Lost River area, most wetlands are seasonal/temporary (57 percent) or semi-permanent (27 percent).

On pasture lands in the King George Study Area, the number of wetlands is about the same as for agricultural land but the surface area of wetlands is nearly double; the average size of wetlands in pasture lands is about 0.89 hectares (2.2 acres). While saline wetlands account for a similar proportion of wetlands on agricultural lands (about 15 percent), they account for almost 50 percent of total wetland area. Seasonal/temporary wetlands are more common in number (70 percent) but are much smaller in size.

In summary, a typical 1.5-section farm in the Lost River or King George Study Areas could have anywhere between 7 and 96 wetlands, and the motivation for draining wetlands is fairly evident. Wetland drainage could increase arable land by as much as 13 percent and farm operations would be more efficient if farmers no longer have to manoeuvre equipment around numerous, small wetland areas.

5.2 BENEFITS OF WETLAND DRAINAGE

There are various types of potential benefits that can be derived from wetland drainage. Increased farm income due to crop production on drained lands represents the most obvious benefit, but draining wetland can also enhance productivity and reduce operating costs on adjacent lands. These types of benefits and the costs associate with wetland drainage are examined below.

5.2.1 Primary Benefits

From the perspective of agriculture, the primary benefit of wetland drainage is increased crop production from expansion of the arable land base. Depending on the crop, the potential gross benefits of draining and cultivating wetland areas could be on the order of \$247 to \$346 per hectare per year (\$100 to \$140 per acre) in the Lost River Study Area, and from \$222 to \$296 per hectare per year (\$90 to \$120 per acre) in the King George Study Area. These estimates are based on the average crop yields and price estimates provided in tables 31 and 32, respectively. The difference in potential gross revenues between the two study areas is due to different soil conditions and fertility; the dark brown soils of the Lost River area are more productive than the brown soils in the King George area.

An estimate of the actual gross benefits of cultivating a hectare of land in the study areas is provided in Table 33. These estimates reflect the mix of crop types in each area (as per Table 2), average yields, and prices based on the most recent five-year average. The results suggest average gross revenues of about \$223 per hectare in the Lost River Study Area and \$163 per hectare in the King George Study Area.

TABLE 31

AVERAGE CROP YIELDS
(Kg/ha)

	Lost River			King George		
	5 yr Avg	10 yr Avg	15 yr Avg	5 yr Avg	10 yr Avg	15 yr Avg
Spring Wheat	1710	1742	1774	1228	1564	1665
Durum Wheat	1801	1791	1814	1159	1438	1552
Oats	1619	1804	1794	1203	1478	1623
Barley	2076	2090	2105	1473	1856	2046
Canola	1114	1065	1065	558	756	801
Flaxseed	1048	1030	981	830	912	899

Source: Saskatchewan Agriculture. The 5-year average refers to 1984-88, the 10-year average is for 1979-88 and the 15-year average is shown for 1974-88.

TABLE 32

AVERAGE CROP PRICES
($/tonne)

	5 Year Average	10 Year Average	1989 Forecast
Spring Wheat	128.34	158.32	154
Durum Wheat	169.82	146.60	177
Oats	93.05	103.90	161
Barley	93.65	109.10	115
Canola	n.a.	n.a.	300
Flaxseed	n.a.	n.a.	330

Source: Saskatchewan Agriculture. The 5-year average refers to 1984-88, the 10-year average is for 1979-88 and the 15-year average is shows for 1974-88. The 1989 forecast is taken from Cost of Producing Grain Crops in Saskatchewan, 1989. These prices exclude subsidies.

n.a. = not available

TABLE 33

ESTIMATED GROSS REVENUES PER HECTARE IN THE STUDY AREAS

	Lost River				King George			
	% of land	Yield (tonnes)	Price per tonne	Total Revenue	% of land	Yield (tonnes)	$ per tonne	Total Revenue
Spring Wheat	79	1.710	128.34	$173.37	70	1.228	128.34	$110.32
Durum Wheat	8	1.801	169.82	$ 24.47	19	1.159	169.82	$ 37.40
Barley	12	2.076	93.65	$ 23.33	10	1.473	93.65	$ 13.79
Oats	1	1.619	93.05	$ 1.51	1	1.203	93.05	$ 1.12
Weighted Average	100			$222.68	100			$162.63

An alternative assessment of gross revenues can be found in Table 34 which shows an average of $216 per hectare for the Lost River Area and $193 per hectare in the King George Study Area. These estimates are based on a survey of farmers in the area and reflect their expectations for 1989 rather than actual revenues received. While the results are close to the estimates provided in Table 33, it appears that farmers in the Lost River Study Area were being slightly pessimistic in comparing expectations for 1989 with historical trends whereas farmers in the King George Study Area were quite optimistic for 1989. For purposes of this analysis, the estimates derived in Table 33 have been adopted since they are assumed to be more representative of farm incomes in the longer term. These estimates do not include any subsidies, nor do they reflect the costs of drainage which are addressed later in this chapter.

To estimate the net annual benefits from cultivation of wetlands, the annual operating costs must be subtracted. An estimate of these annual operating costs is provided in Table 34. These numbers are based on records from a sample of farms operating in the brown and dark brown soil zones and are believed to be much more accurate than the projected revenues (Saskatchewan Agriculture, pers. comm.). The data are based on a farm of 728 to 850 hectares (1,800 to 2,100 acres) in size of which about 70 percent is cropped. Once these costs are subtracted, the annual net benefits (excluding drainage costs) of draining and cultivating wetland areas would amount to about $100 per hectare per year ($45 per acre) in the Lost River area and $92 per hectare per year ($44 per acre) in the King George area.

TABLE 34
ESTIMATED COST OF AGRICULTURAL PRODUCTION IN SASKATCHEWAN, 1989, BY SOIL ZONE
(Average Per Cultivated Hectare (Acre))

	Dark Brown Soil Zone		Brown Soil Zone	
Income:	per acre	per ha	per acre	per ha
Grain	85.65	211.65	77.21	190.79
Miscellaneous	1.61	3.98	0.96	2.37
Total	$87.26	$215.62	$78.17	$193.16
Cash Costs:				
Crop Inputs:				
Seed	4.53	11.19	3.95	9.76
Nitrogen Fertilizer	2.24	5.54	0.81	2.00
Phosphorus Fertilizer	2.62	6.47	2.00	4.94
Other Fertilizer	1.25	3.09	0.59	1.46
Chemicals	6.47	15.99	5.99	14.80
Crop Insurance	1.83	4.52	1.88	4.65
Hail Insurance	0.42	1.04	0.65	1.61
Miscellaneous	0.05	0.12	0.43	1.06
Sub-total Crop Inputs	$19.41	$47.96	$16.30	$40.28
Equipment & Building Expenses:				
Fuel, Oil & Lubricants	3.55	8.77	3.48	8.60
Repair & Maintenance	3.87	9.56	3.75	9.27
Miscellaneous	0.30	0.74	0.28	0.69
Indirect equipment	2.20	5.44	2.42	5.98
Total Equipment and Building Expenses	$9.92	$24.51	$9.93	$24.54
Other Expenses:				
Labour	8.36	20.66	6.71	16.58
Property Taxes	2.05	5.07	1.96	4.84
Miscellaneous	3.93	9.71	3.48	8.60

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	Dark Brown Soil Zone		Brown Soil Zone	
Operating Interest	1.65	4.08	1.43	3.53
Total Other Expenses	$15.99	$39.51	$13.58	$33.55
Total Cash Costs	45.32	111.99	39.81	98.37
Depreciation	$12.80	$31.63	$11.85	$29.28
Total Cash and Depreciation Costs	58.12	143.62	51.66	127.65
Net Farm Cash Income	$41.94	$103.63	$38.36	$94.79
Net Farm Income	$29.14	$72.00	$26.51	$65.51

Source: Saskatchewan Agriculture (1989). Cost of producing Grain Crops in Saskatchewan, 1989. Economics Branch. These costs are based on actual costs reported by a sample of farmers in each area and may not reflect actual costs due to price distortions caused by various forms of subsidies.

	Lost River	King George
Grain Income	$223.00	$163.00
Total Cash Costs	$112.00	$98.00
Net Income	$111.00	$65.00

As wetland drainage would allow farmers to cultivate more of their land, only the variable costs associated with land cultivation have been included while fixed costs and depreciation would remain relatively constant.

To demonstrate the magnitude of these benefits for farmers in the Study Areas, wetland configurations for a 1.5-section (389 hectares or 960 acres) farm have been assumed, using the estimates contained in tables 29 and 30. The annual net value of crops that could be produced if all temporary/seasonal and semi-permanent wetland areas were drained would range between $137 and $2 420, depending on wetland density:

	Lost River		King George	
Wetland Density	Wetland Area (ha)	Increased Revenues	Wetland Area (ha)	Increased Revenues
Low	14.2	$1 576	2.1	$137
Medium	18.8	$2 087	15.9	$1 034
High	21.8	$2 420	20.7	$1 346

Such benefits would occur annually, and the resulting increase in farm income demonstrates why wetland drainage can be an attractive proposition.

5.2.2 Efficiency Benefits

A number of other related agricultural benefits can also be attributed to wetland drainage and result from increased efficiency on lands currently under cultivation. These have been summarized in Anderson's 1986[14] study of wetland drainage in the Peace River country of Alberta and include the following:

- improved timing of operations;
- reduced transitional area production costs;
- improved crop quality (transitional lands);
- improved field patterns; and,
- improved crop quality (upland).

As noted below, not all of these efficiency benefits could be realized by wetland drainage in the prairie pothole region.

Improved Timing of Operations

In areas having seasonal and temporary wetlands, farmers are sometimes forced to delay spring seeding and other operations until these wetlands dry. By draining wetlands, it may be possible for farmers to increase the number of working days in both the spring and fall such that they can switch crops, grow later maturing and higher yielding crops, and can improve the harvest schedule. As summarized by Anderson (1986), the benefits resulting from improved timing amount to about 0.25 percent of gross farm revenue per hectare for every wetland drained per section of land, to a maximum of five percent. Such benefits would occur annually, starting three years after drainage is completed.

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[14] The Anderson report is a synthesis of the methodology and data contained in two previous studies which examined the nature of secondary benefits from wetland drainage. These two reports include: Pedology Consultants (1985). Inventory of Alberta's Drainage Requirements - Soils and Agronomy Component - Summary. ISCOD, Edmonton.
Marv Anderson & Associates (1985). Inventory of Alberta's Drainage Requirements - Economics Component - Summary. ISCOD, Edmonton.

For the two study areas, it is unlikely that increased efficiency from wetland drainage would produce significant benefits as lands in the prairie pothole areas often suffer from lack of moisture in the spring rather than excessive moisture. In addition, the prairie pothole area has better drainage than soils in the Peace River country and also faces a longer growing season. Thus, wetland drainage is not likely to have a significant impact on the timing of farm operations in the two study areas.

For purposes of estimation, two scenarios regarding potential benefits from improved timing have been assumed. As a base case, it is assumed that wetland drainage will have no such benefits whatsoever. Alternatively, it has been assumed that these benefits would be equivalent to about half of the corresponding benefits in the Peace River area. Based on a 389-hectare farm (960 acres) of which 70 percent of land is under cultivation, the efficiency benefits to be derived from improved timing of operations due to wetland drainage would be as follows:

	Lost River		King George	
Wetland Density	Number Per Section	Operating Benefits	Number Per Section	Operating Benefits
Low	13.6	$1 034	2.5	$139
Medium	23.6	$1 517	15.9	$882
High	37.1	$1 517	29.5	$1 637

As calculated, the benefits resulting from improved operations would actually exceed the increased income from the expansion in production acreage in some cases. As will be described later, this assumption regarding increased efficiency due to improved timing has a significant effect on the outcome of the overall analysis.

Reduced Transitional Area Production Costs

Lands bordering wetlands tend to be affected by excessive wetness through shallow watertables and occasional ponding. Depending on soils, slope, hydrological and geological conditions, these transitional lands tend to extend about 6 to 18 metres (20 to 60 feet) beyond the wetland boundary. To effectively farm these transitional lands, farmers must make several passes with machinery with the result that there are some overlaps leading to wastage of seed, fertilizer and chemicals. While reliable estimates of the extent of these overlaps is not available, Anderson (1986) assumed full double coverage over an area extending (50 feet) 15 metres back from the wetland edge.

By draining wetlands, farmers would only have to make a single pass over these lands. The resulting reduction in farm costs would be then be equivalent to the value of seed, fertilizer and chemicals applied during a single pass. Such benefits would also occur in the third year after wetland areas have been drained.

Given wetland configurations in the study areas (see Tables 29 and 30), it is estimated that there are about 0.6 to 0.9 hectares of transitional lands for every hectare of wetlands, depending on wetland density and type. Accordingly, the following annual reductions in production costs on transitional lands on a typical 1.5-section farm could be achieved by wetland drainage:

	Lost River		King George	
Wetland Density	Transitional Land (ha)	Cost Savings	Transitional Land (ha)	Cost Savings
Low	8.6	$364	1.6	$53
Medium	13.8	$583	10.7	$353
High	20.0	$846	17.4	$574

Thus, there are considerable cost savings to be gained, especially in the Lost River Study Area where there is a much greater density of wetlands.

Improved Crop Quality on Transitional Lands

Another problem with transitional lands is that they tend to be less productive due to increased problems of weed infestations, green patches, lodging and susceptibility to frost. In addition, excess fertilizers or chemicals resulting from overlaps during application may also damage crops. According to Anderson (1986), the value of production on transitional lands is about 10 percent below gross revenues from production on upland areas. Wetland drainage would eliminate these transitional areas and it is anticipated that productivity, as measured by way of yield, bushel weight or moisture content, would increase to normal levels for the surrounding area. A 10 percent increase in gross revenues for transitional lands would translate into the following benefits for a typical 1.5-section farm:

	Lost River		King George	
Wetland Density	Transitional Land (ha)	Improved Quality	Transitional Land (ha)	Improved Quality
Low	8.6	$192	1.6	$26
Medium	13.8	$308	10.7	$174
High	20.0	$446	17.4	$284

Thus, wetland drainage could lead to annual increases of between $26 and $446 per year per farm through improved productivity on transitional lands surrounding wetlands.

Improved Field Patterns

In order to manoeuvre around wetland areas, farmers face higher labour and machinery costs due to increased turning time and frequent overlaps. The extent to which these costs are above normal will depend on the number, size, location and extent of wetlands areas. One analysis based on computer modelling of three case studies in Northern Alberta determined that these incremental costs amounted to about four percent of variable machinery-related production costs, including labour but excluding seed, fertilizer, chemicals, overhead and depreciation. Anderson (1986) calculated that this is equivalent to about one percent of total production costs per hectare.

Draining of wetlands would eliminate these incremental operating costs by allowing farmers to make fewer turns and reduce overlap. The resulting one percent reduction in total production costs would amount to an annual benefit of between $350 and $390 for a 1.5-section farm in the King George and Lost River study areas.

Improved Crop Quality on Uplands

Wetlands can also have a negative impact on crop quality on adjacent upland areas. In the Peace River area, crops near wetlands can take longer to dry at harvest time and may be more difficult to combine, thereby delaying the harvest and producing lower yields. The impact on yields is related to the amount of wetlands adjacent to upland areas. According to Anderson (1986), lower crop yields on upland areas, as expressed in terms of reductions in gross revenue per hectare, would be as follows:

0.5 percent for 0-10 hectares of wetland per section
1.0 percent for 10-20 hectares of wetland per section
1.5 percent for 20-30 hectares of wetland per section
2.0 percent for more than 30 hectares of wetland per section

Draining of wetlands would eliminate these problems with the result that gross revenues from crops on upland areas would increase to average levels for the surrounding area.

For farms in the study areas, it is unlikely that crops adjacent to wetland areas would benefit from wetland drainage since there is a longer harvest season and surplus moisture is seldom a problem. In fact, crop quality on lands adjacent to prairie pothole wetlands may actually be better than elsewhere due to the fact that there is improved season-long soil moisture conditions in these areas. For this reason, changes in crop quality in upland areas have not been assumed to occur due to wetland drainage and, even if they were to occur, such changes might be considered as costs rather than benefits.

5.2.3 Summary of Benefits

As summarized in tables 35 and 36, drainage of all semi-permanent and seasonal/temporary wetlands on a typical 1.5-section farm would produce annual benefits in the range of $600 to $4 100, depending on wetland density and farm location. Benefits would be larger for farms in the Lost River Study Area due to better soil fertility and productivity, and would also be greater on lands with a high wetland density.

It should be noted that, according to Anderson (1986), the efficiency benefits would not occur until the third year of a wetland drainage program, with actual drainage occurring in the first year of the project. Furthermore, all of the primary benefits

TABLE 35

SUMMARY OF AGRICULTURAL BENEFITS RESULTING FROM WETLAND DRAINAGE: LOST RIVER STUDY AREA[1]

	Wetland Density		
	Low	Medium	High
Primary Benefits:	$1 576	$2 087	$2 420
Efficiency Benefits:			
Transitional lands:			
- cost savings	364	583	846
- improved quality	192	308	446
Improved field patterns	390	390	390
Sub-Total (No Timing Benefits)	946	1 281	1 682
Total (No Timing Benefits)	$2 522	$3 368	$4 102
Sub-Total (with Timing Benefits)	1 980	2 798	3 199
Total Benefits (with Timing Benefits)	$3 556	$4 885	$5 618

[1] Assumes drainage of all seasonal/temporary and semi-permanent wetlands in a typical 1.5 section farm.

TABLE 36

SUMMARY OF AGRICULTURAL BENEFITS RESULTING FROM WETLAND DRAINAGE: KING GEORGE STUDY AREA[1]

	Wetland Density		
	Low	Medium	High
Primary Benefits:	$137	$1 034	$1 346
Efficiency Benefits:			
Transitional lands:			
- cost savings	53	353	574
- improved quality	26	174	284
Improved field patterns	350	350	350
Sub-Total (No Timing Benefits)	429	877	1 208
Total Benefits (No Timing Benefits)	$566	$1 911	$2 554
Sub-Total (with Timing Benefits)	568	1 759	2 845
Total Benefits (with Timing Benefits)	$705	$2 793	$4 191

[1] Assumes drainage of all seasonal/temporary and semi-permanent wetlands on a typical 1.5-section farm.

from expansion of the agricultural land base would not occur until the fifth year of the project. Furthermore, about 70 percent of primary benefits would be experienced in the third year and 85 percent in the fourth year.

In reviewing the estimates of total benefits resulting from wetland drainage, the efficiency benefits were equivalent to 60 to 90 percent of the primary benefits, assuming that no increased efficiency due to improved timing was realized. This result is consistent with observations from Anderson's work that efficiency benefits from wetland drainage were often equivalent in size to the primary benefits. If some benefits from improved timing are factored into the calculation, however, the results are significantly different. In these cases, efficiency gains are 26 to 70 percent larger than the primary benefits. For this reason, it is unlikely that the timing benefits apparent from wetland drainage in the Peace River area are applicable to the estimation of the benefits of wetland drainage in the prairie pothole region.

5.3 COSTS OF WETLAND DRAINAGE AND DEVELOPMENT

Before the potential net benefits of draining wetlands for agricultural purposes can be estimated, the actual costs of wetland drainage must be considered.

5.3.1 Drainage and Development Costs

Reliable generic estimates of drainage and development costs are difficult to provide, as actual costs tend to reflect the size and types of wetlands at each specific site. Nevertheless, information from a number of studies in Alberta and input from the Saskatchewan Water Corporation has allowed estimation of approximate costs.

Depending on topography and the engineering approach to be applied to wetland drainage, typical on-farm drainage costs in west-central Saskatchewan range from $150 to $2 540 per hectare ($60 to $1 030 per acre; refer to Table 37). The highest costs are for construction of grid system drains, but methods like random field ditches, with or without subsurface drains, tend to be less expensive - about $1 360 to $990 per hectare, respectively. While the high cost alternative would be required for draining permanent wetlands, a combination of the less expensive approaches (assumed to average about $1 235 per hectare) could be used for draining seasonal/temporary wetlands.

Based on the wetland configurations for typical 1.5-section farms in each of the study areas, the total cost of draining all seasonal/temporary and semi-permanent wetlands could range from about $2 600 to $27 000, depending on wetland density and location:

	Lost River		King George	
Wetland Density	Wetland Area (ha)	Drainage Costs	Wetland Area (ha)	Drainage Costs
Low	14.2	$17 540	2.1	$2 590
Medium	18.8	$23 220	15.9	$19 640
High	21.8	$26 920	20.7	$25 560

These costs would be incurred in the first year of a wetland drainage project. After completion, it is assumed that annual operating and maintenance costs for the drainage projects would amount to about two percent of the total capital cost of the drainage projects.

Following drainage and prior to cultivation, farmers will have to incur land preparation costs, including clearing of brush and treatment with fertilizer and/or

TABLE 37

TYPICAL ON-FARM DRAINAGE COSTS IN WEST CENTRAL SASKATCHEWAN
(1989 Dollars)

Topography	Type of Drainage	Cost/Reclaimed Acre	Cost/Reclaimed Hectare
Undulating (potholes)	Random Field Ditches & Grassed Waterways	$400	$990
Undulating to Rolling (potholes)	Random Field Ditches & Subsurface Drains (pothole drainage)	$550	$1 360
Undulating	Grid System Drains	$1030	$2 540
Level (Sheetwater flooding)	Parallel Field Ditches	$ 60	$150

Source: Adapted from Jensen Engineering (1985). Inventory of Alberta's Drainage Requirements - Engineering Summary Report. ISCOD. Estimates of costs for west central Saskatchewan provided by Cas Rogal, Saskatchewan Water Corporation, Outlook, Saskatchewan, March 1, 1990.

lime, if required. These land preparation costs will also vary significantly from site-to-site but, for Alberta, clearing costs were estimated to be about $555 per hectare ($225 per acre) for shrubs and trees, $306 per hectare ($124 per acre) for herbaceous cover and $94 per hectare ($38 per acre) in other (sheetwater) areas in 1986[15]. For purposes of this analysis, an estimate of about $370 per hectare ($150 per acre in 1989 dollars) has been assumed. For a typical 1.5-section farm, these land preparation costs would range between about $800 and $8 000, depending on wetland density:

	Lost River		King George	
Wetland Density	Wetland Area (ha)	Land Prep. Costs	Wetland Area (ha)	Land Prep. Costs
Low	14.2	$5 260	2.1	$780
Medium	18.8	$6 970	15.9	$5 890
High	21.8	$8 080	20.7	$7 670

These land preparation costs would occur in the second year of the drainage program.

5.3.2 Other Costs

In addition to the costs of actually draining and cleaning wetlands for cultivation, wetland drainage will deprive farmers of various benefits that they currently derive from using wetlands for various other purposes. As detailed in Table 38, about 62 percent of farms in both the Lost River and King George study areas include wetland areas and, of these farms, more than half use wetlands for some agricultural purpose, including hay production, crop production, grazing or pasture, water supply

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[15] Adapted from: Visser, P. (1984). A Study of Land Development Costs in the Peace River Region, 1984. Alberta Agriculture.

TABLE 38

CURRENT USE OF WETLANDS FOR AGRICULTURAL PURPOSES
(Percent of Responses)

	Lost River Study Area (n=50)	King George Study Area (n=52)	Southern Saskatchewan (n=65)
Farms with wetland areas	62.0	62.0	60.9
Use wetlands for some purpose	64.5	53.1	61.0
- hay production	50.0	63.2	40.6
- crop/cultivate	13.6	15.8	31.3
- grazing/pasture	4.5	15.8	9.4
- water supply	18.2	5.2	15.6
- other	13.7	0.0	3.1
Cultivate wetlands during dry years	52.0	46.2	30.0

or other purposes. The highest incidence of wetland use (about 65 percent of farms with wetland areas) was reported in the Lost River area where hay production and water supply were the most common uses of wetlands. Hay production was also common on wetlands in the King George area, but only about 53 percent of farms with wetland areas reported using these areas for some purpose. Furthermore, nearly half of all farms in both study areas reported cultivating wetland areas in dry years. This practice is more prevalent in the Lost River Study Area than elsewhere.

Given these current wetland utilization practices, wetland drainage would eliminate some of the benefits that are currently provided by wetlands in their existing state. This loss represents a form of opportunity cost which has not been quantified or incorporated into the final evaluation of the net benefits of wetland drainage for agricultural purposes.

5.4 NET BENEFITS TO AGRICULTURE

To provide a analysis of the net benefits to agriculture that would result from wetland drainage, it is necessary to compare the short-term costs of wetland drainage and land preparation with the long term benefits of increased productivity. To do this analysis, the streams of future benefits and costs have been discounted to present value equivalents using a discount rate of ten percent (net of inflation) over a 30-year time period. This rate of discount reflects the risk to the farmer of investing money in land drainage rather than some other form of saving or investment (opportunity cost of capital). Details of these calculations are provided in Appendix IV, while a summary of results is presented in Tables 39 and 40.

In nearly all cases, the results show that additional drainage and cultivation of wetlands in each of the two study areas is not particularly attractive unless farmers

TABLE 39

ECONOMIC EVALUATION OF WETLAND DRAINAGE AND CULTIVATION, ACCORDING TO WETLAND DENSITY, FOR A TYPICAL 1.5-SECTION FARM: BASE CASE SCENARIO

(1989 Dollars)

				Hectare of Wetland	
	B/C Ratio	IRR*	Total NPV**	NPV	Annual
Lost River Study Area:					
Low Density	0.81	4.27%	$4 400	$309	-$30.00
Medium Density	0.82	4.43%	$5 605	$298	-$29.00
High Density	0.86	5.32%	$4 980	$228	-$22.00
King George Study Area:					
Low Density	1.25	11.81%	$868	$413	$40.00
Medium Density	0.55	N.A.	$11 709	$736	$71.00
High Density	0.57	N.A.	$14 727	$711	-$68.00

* Internal Rate of Return

** Net Present Value

TABLE 40

ECONOMIC EVALUATION OF WETLAND DRAINAGE AND CULTIVATION, ACCORDING TO WETLAND DENSITY, FOR A TYPICAL 1.5-SECTION FARM: HIGH EFFICIENCY BENEFITS SCENARIO

				Hectare of Wetland	
	B/C Ratio	IRR	Total NPV	NPV	Annual
Lost River Study Area:					
Low Density	1.15	10.35%	$3 553	$253	$24.00
Medium Density	1.20	11.00%	$6 063	$323	$31.00
High Density	1.19	10.86%	$6 688	$307	$29.00
King George Study Area:					
Low Density	1.56	15.82%	$1 937	$922	$88.00
Medium Density	0.81	4.24%	$4 925	$310	-$30.00
High Density	0.94	6.80%	$2 136	$103	-$10.00

* Internal Rate of Return

** Net Present Value

can realize a substantial increase in efficiency benefits. For the base case, in which no timing benefits are assumed (Table 39), there is only one instance where benefits would actually exceed costs over the long term. On an annualized basis, wetland drainage would result in losses of between $22 and $71 per hectare. These losses would be even greater if farmers had to borrow money to undertake wetland drainage in the first place since financing costs (interest) have not been included in the analysis. The results also show that the potential benefits of wetland drainage are significantly better for farms in the Lost River Study Area, although costs would still exceed benefits, and this is a reflection of the more productive soil conditions in this region. The only case in which drainage would appear to be economically viable applies for farms with low-density wetlands in the King George Study Area. This would appear to result because considerable gains in efficiency could be gained by draining a small amount of wetland area.

Table 40 provides an economic evaluation of wetland drainage under the assumption that farming efficiency would be improved considerably due to timing benefits. As described earlier, these potential timing benefits could be equivalent to all other types of efficiency benefits combined, such that these efficiency benefits would greatly exceed the annual value of crops produced on drained wetlands on an annual basis (primary benefits). However, even with a doubling of efficiency benefits, the wisdom of draining additional wetlands remains dubious. While benefits exceed costs in nearly all cases, the internal rate of return on investment (IRR) remains quite low. The internal rate of return is estimated on the basis of cash flow projections for each drainage project and represents the highest rate of interest that a farmer could incur to obtain funding for drainage without losing any money on the project. With current interest rates being on the order of 15 percent, the internal rate of return calculations suggest that wetland drainage is not financially viable if farmers have to rely on borrowed money to pay the initial capital costs.

A number of conclusions can be drawn from the information in Table 40. First, with high efficiency benefits, wetland drainage in the Lost River Study Area is much more viable than in the King George Study Area and, as noted before, this reflects soil conditions. Second, the total benefits realized over a 30-year period would be equivalent to a one-time payment of about $250 to $323 per hectare ($100 to $130 per acre) for farms in the Lost River Study Area, and such a payment is consistent with the price of agricultural land. Alternatively, the analysis suggests that these net benefits would be similar to annual payments ranging from $24 to $31 per hectare.

5.5 ANALYSIS

There are a number of conclusions that can be drawn from this analysis of the potential agricultural benefits that could be derived from drainage and cultivation of wetlands in the two study areas. First, the results of the overall analysis are very sensitive to assumptions about the relative size of efficiency benefits vis-a-vis primary benefits. The base case analysis, which assumes efficiency benefits are less than primary benefits, shows that wetland drainage is not viable whereas drainage becomes marginally viable if the size of these efficiency benefits is increased substantially. Better understanding of the magnitude of these efficiency benefits is required if a more detailed assessment of wetland drainage is to be undertaken. Further research into the importance of some of these efficiency benefits is currently being assessed at various farms in Alberta as part of the On-Farm Water Management Study currently being undertaken by the provincial government[16]. Preliminary results suggest that the efficiency and primary benefits are probably similar in magnitude, and this finding is consistent with the base case results provided in Table 39.

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[16] The study is being undertaken by W-E-R Engineering Ltd. on behalf of Alberta Agriculture, Alberta Environment, Alberta Forestry, Lands and Wildlife, Alberta Municipal Affairs and the Alberta Water Resources Commission.

A second conclusion is that, under present conditions, further wetland drainage for a typical 1.5-section farm in either of the study areas does not appear to be economically viable. Unless there are substantial efficiency gains to be realized, drainage costs will exceed benefits in the long run. This conclusion appears to make sense, since a reversal of the results (benefits greater than costs) would indicate that a significant number of wetland drainage projects should be underway at the present time and such is not the case.

As summarized in Table 41, the results of the household survey indicate that, only a limited number of drainage projects are being developed. In southern Saskatchewan, for example, only about three percent of farmers claimed to have drained any wetland areas in the last five years. Wetland drainage was reported by about the same percentage of farmers in the King George area, but was more common in the Lost River area where drainage activities in the last five years were reported by almost 17 percent of farmers. The main reasons for undertaking wetland drainage were to increase the amount of land under production, clean up weedy areas, make manoeuvring of machinery easier, and discourage hunters. Some farmers also reported draining wetlands on a temporary basis, but the proportion acknowledging this practice was quite small - six percent or less. A more common practice is to cultivate right to the edge of the wetlands. This was reported by 86 percent of farmers in the Lost River Study Area, but only about half of the farmers in the other two locations.

Overall, the survey results coincide with the economic analysis in suggesting that further drainage of wetlands for agricultural purposes will be limited to areas with the most productive soil conditions. Most of the viable wetland drainage projects have already occurred and for most remaining wetlands drainage is simply not

TABLE 41

CURRENT STATUS OF WETLAND DRAINAGE FOR AGRICULTURAL PURPOSES

(Percent of Responses)

	Lost River Study Area (n = 50)	King George Study Area (n = 50)	Southern Saskatchewan (n = 69)
Farms with wetland areas	62.0	62.0	60.9
Extent of wetlands			
- average acres	195.8	48.5	31.8
- percent of land	10.5	3.8	0.3
Drained wetlands in the past 5 years	16.7	4.1	3.3
Temporarily drained wetlands	6.0	1.9	1.4
Cultivate to edge of wetlands	86.0	51.0	50.0
Plan to drain more wetlands	10.2	3.8	0.0

viable under current conditions. This conclusion also supports the use of the base case scenario for evaluating the economics of wetland drainage.

One additional observation about the economic analysis is that, from the farmer's perspective, it is not entirely complete. The production costs and revenues used in the calculations do not reflect subsidies and other forms of support for the agricultural community. With the addition of these subsidies, wetland drainage may be more viable for individual farmers than shown. On the other hand, some costs have not been addressed and would have an adverse effect on the calculations. Such costs would include the benefits derived from agricultural use of existing wetland areas and the interest costs on borrowed money used to pay the initial high cost of drainage projects.

5.6 DISCUSSION

Based on current conditions and the expectations of the farming communities, the trend toward a limited amount of drainage of wetland areas can be expected to continue in the two study areas in future years. Survey results showed that, while wetland drainage was not being considered by farmers in the southern part of Saskatchewan, such projects are being considered by nearly four percent of farmers in the King George area and more than 10 percent in the Lost River area. In most cases, the motivation for wetland drainage is to increase the amount of land under cultivation. Other reasons include increased farming efficiency and potential irrigation.

The survey also asked questions about the extent to which farmers would have to be compensated to allow drained areas to return to a wetland state or to forego draining wetlands at some time in the future. Unfortunately, owing to the relatively small number of farmers who had recently drained wetlands or were contemplating doing so in the future was too small to permit meaningful analysis for each of the three survey groups. However, when the information was pooled, it would appear that an annual payment of about $90 per acre (± $33, with a median value of $90) would be sufficient to compensate farmers for allowing wetlands to return to a natural state. This amount is much larger than the maximum annualized return that farmers would obtain from draining and cultivating additional wetlands but it is quite consistent with annual net income being derived from previously-drained wetlands ($111 per hectare in the Lost River Study Area and $65 per hectare for the King George Study Area - see Section 5.2.1).

Despite the apparent trend toward continued wetland drainage, the majority of landowners consider wetlands to be an asset. As detailed in Table 42, attitudes toward wetlands were fairly consistent throughout the province, with less than three out of 10 landowners considering wetlands to be a nuisance.

Where wetlands were considered a nuisance, all reasons related to the difficulties that wetlands pose for farming. Nearly half of the responses identified wetlands as being a general nuisance to farming while another common response was that wetlands occupied quality agricultural land; this perception was particularly noticeable for respondents from the Lost River Study Area. Other, more specific reasons included increased crop losses from waterfowl and wildlife, breeding areas for insects and weeds, and the belief that wetlands drain water away from crops.

For landowners who considered wetlands as assets, a broad list of non-agricultural wetland benefits was identified. Most commonly, these reasons related to wildlife, waterfowl and habitat. However, many landowners were aware of the hydrologic

TABLE 42

LANDOWNER ATTITUDES TOWARD WETLANDS
(Percent of Responses)

	Lost River Study Area (n=50)	King George Study Area (n=52)	Southern Saskatchewan (n=69)
Wetlands are a Nuisance:			
Percent of Responses:	28.0	23.9	21.3
Nuisance to farming	46.7	46.1	40.0
Wildlife/birds	6.7	38.5	33.3
Take quality land	33.3	0.0	26.7
Breeds grasshoppers	6.7	0.0	0.0
Drain water from crops	6.7	0.0	0.0
Weeds	0.0	15.4	0.0
Wetlands are an Asset:			
Percent of Responses:	72.0	76.1	78.7
Waterfowl/wildlife	45.2	28.9	47.8
Water attracts water	7.1	42.1	6.5
Traps/retains water	9.5	18.4	4.3
Prevents erosion	7.1	2.6	4.3
Stock watering	11.9	2.6	2.2
Balance of nature	4.8	5.3	6.5
Irrigation water	4.8	0.0	4.3
Grazing land	2.4	0.0	0.0
Cutting of feed	4.8	0.0	2.2
Hunting	2.4	0.0	0.0
Payments from NAWMP	0.0	0.0	4.3
Survival	0.0	0.0	10.9
Other	0.0	0.0	6.5

functions served by wetlands, notably the idea that wetlands attract precipitation and that wetlands retain moisture. For some landowners, wetlands were recognized for their agricultural benefits as a source of stock watering and irrigation water, as grazing lands and as a source of feed. Very few landowners identified hunting as an important asset of wetlands, and some expect that, through the North American Waterfowl Management Plan, wetlands will provide a regular source of income.

6.0 THE OPTIMAL USE OF PRAIRIE POTHOLE WETLANDS

To this point in the analysis, the various benefits and costs associated with alternative uses of prairie pothole wetlands have been identified and evaluated where possible. It is now necessary to consider which of these uses, agricultural development or maintaining the current status of wetlands, is more efficient from a social perspective. And, in order to achieve this optimal use of wetlands, what institutional barriers or incentive programs need to be developed or eliminated?

6.1 BENEFIT/COST ANALYSIS

To test for the best use of a resource from a social perspective, resource economists employ benefit/cost analysis to determine whether the total benefits of proceeding with a development proposal actually outweigh all the costs. For wetlands, the potential benefits to be derived from agricultural development must be contrasted with the benefits derived from all the various wetland functions that would be foregone as a result of this development.

For pothole wetlands in the two study areas, a conservative estimate of some of the annual benefits generated by wetlands was developed in Chapter 4 (refer to Table 28). Similarly, the annualized benefits of converting wetlands to agricultural production were estimated in Chapter 5 (see tables 39 and 40). These estimates are compared in Table 43.

What the analysis suggests is that, based on the extent of quantifiable recreational benefits that would be forgone, additional wetland drainage for agricultural purposes is not economically or socially efficient in either of the two study areas. Regardless of wetland density, the value of the recreational benefits being generated exceeds the value of increased agricultural output and improved efficiency, as estimated for

TABLE 43

COMPARISON OF THE BENEFITS AND COSTS OF ADDITIONAL WETLAND DRAINAGE FOR AGRICULTURAL PURPOSES

(1989 Dollars Per Hectare)

	Annualized Agricultural Benefits		Annual Provincial Benefits Foregone[2]	Annual Provincial Net Benefits	
	Base Case	High Efficiency		Base Case	High Efficiency
Lost River Study Area					
Low Density	-$30	$24	$68	-$98	-$44
Medium Density	-$29	$31	$68	-$97	-$37
High Density	-$22	$29	$68	-$90	-$39
King George Study Area					
Low Density	-$40	$88	$136	-$96	-$48
Medium Density	-$71	-$30	$136	-$207	-$166
High Density	-$68	-$10	$136	-$204	-$146

[1] The extent of agricultural benefits of wetland drainage varies from year-to-year and the annualized benefits have been calculated by determining the annual payment that would be required to obtain the same net present value over a 30-year period.

[2] As described earlier, these benefits foregone include only the recreational functions of wetlands. Other wetland functions also contribute benefits but these have not been quantified. These recreational benefits are based on survey results which have been estimated by asking recreationists about their willingness-to-pay to visit wetland areas. However, the correct measure of value is based on the amount of compensation that recreationists would require to forego these opportunities (willingness-to-sell) and this value has been found to be at least twice as great as estimates based on willingness-to-pay.

the base case scenario, by at least $90 per hectare. And, even if substantially greater efficiency benefits were to be realized, costs still exceed benefits by at least $37 per hectare. Furthermore, the analysis provides only a conservative estimate of the opportunity costs of wetland drainage; only a few of the wetland functions have been evaluated and agricultural benefits derived from existing uses of the wetlands have been ignored. Lastly, the costs of agricultural subsidies had not been factored into the cost: benefit analyses. According to one source, these subsidies amount to $106 per hectare for a Saskatchewan grain farm (Girt 1990). Clearly, further wetland drainage for agricultural purposes is not in the best interest of the province.

While the results in Table 43 apply to lands having typical wetland configurations in the study area, the conclusions regarding the optimal use of land cannot be universally applied. The methodology used for estimating the agricultural benefits of wetland drainage reflects the size, number and type of wetlands on each farm, but the data relating to potential recreational benefits applies only to non-saline wetlands. It is likely that recreational benefits are much higher for permanent wetlands and lower for temporary/seasonal wetlands, but there is insufficient data relating to the biological and recreational carrying capacity of different wetland types for accurate estimates of value to be derived. Similarly, the agricultural data are based on two very general categories of soil capability, but there are probably variations within each area such that potential agricultural benefits may actually exceed the value of various wetland functions in some cases. Without more information on the conservation and potential agricultural values associated with individual wetlands, rather than typical wetlands, it is not possible to determine which use of a specific wetland, development for agriculture or conservation, is optimal.

To assist in making decisions about the optimal use of existing wetland, the results in Table 43 suggest that the follow factors will need to be considered:

- soil conditions and productivity - Lands in the Lost River Study Area have more productive soils than in the King George Study Area so the potential benefits of wetland drainage for agricultural purposes are greater;

- wetland density - Drainage of low density wetlands seems to provide greater agricultural benefits than does drainage in areas of medium and high density wetlands. This is probably due to the observation that, in areas of low density wetlands, major gains in farm efficiency can be achieved with relatively small drainage costs, so wetland drainage may be justifiable; and,

- wetland size - According to the analysis of potential agricultural benefits resulting from wetland drainage, the size of wetlands to be drained does not seem to have a significant impact on the size of these potential benefits. However, the importance of wetlands functions may be directly proportional to wetland area (especially for hydrological and flood control functions) so it may be less desirable from an agricultural perspective to drain larger wetlands.

These observations apply to those farms that have wetland configurations that are considered to be typical for each of the study areas.

While the preceding analysis can be used to test the efficiency of additional wetland drainage, the conversion of existing agricultural lands back to wetlands involves a different type of comparison. In this case, the net value of agricultural production foregone would be equal to the primary benefits of agricultural production (section 5.2.1) with the assumption that any previous expenditures on wetland drainage would be treated as sunk costs. As shown in Table 44, a simple benefit-cost comparison shows that, from a provincial accounting perspective, conversion of agricultural lands back to wetlands is appropriate in the King George Study Area where soil capability is lower and wetland values are higher.

TABLE 44

COMPARISON OF THE ANNUAL BENEFITS AND COSTS OF CONVERTING AGRICULTURAL LANDS TO WETLANDS

(1989 Dollars Per Hectare)

		Recreational Benefits			Annual Net Benefits	
	Agricultural Benefits Foregone	Sask.	U.S.	Total	Sask	Total
Lost River Study Area	$111	$68	$88	$156	-$43	$45
King George Study Area	$65	$136	$113	$249	$71	$184

For the Lost River Study Area, however, conversion of agricultural land to wetlands does not appear to be economically efficient from a provincial perspective. The value of agricultural production exceeds the value of those wetland functions included in the analysis by about $43 per hectare and it is not clear from the available information whether or not the other benefits attributable to wetlands would exceed this amount. Yet, if a continental perspective to the problem of wetland conservation is adopted, the added benefits of recreational opportunities in the U.S. would tip the analysis in favour of conversion back to wetlands. From this continental perspective, the value of recreational opportunities that could be generated would exceed the net value of agricultural production by about $45 per hectare per year.

Again, it must be noted that these conclusions apply to average lands in the two study areas. There will be instances in which highly-productive lands would be best left in agricultural uses. And, if the number of wetlands were to increase, it is expected that the marginal value of these lands would start to decrease such that the results of these benefit-cost comparisons would change. However, with no information regarding the marginal values of individual pieces of agricultural lands or wetlands, it is impossible to determine what mix of these two land uses would maximize benefits from a provincial or continental perspective.

6.2 DISTRIBUTIONAL IMPLICATIONS

In examining the various costs and benefits associated with wetland drainage, it must be remembered that there are three different groups included in the analysis:

- farmers/landowners who own the land and would potentially benefit most if wetlands were drained and subsequently used for agricultural development;

- farmers and other residents of Saskatchewan (and other parts of Canada) who enjoy many of the benefits arising from the more-obvious wetland functions like waterfowl production and recreation; and,

- waterfowl hunters in the United States who would also benefit from waterfowl production if wetlands were left undeveloped.

Selection of the optimal use of wetlands then depends upon which question is being asked (drainage of additional wetlands or conversion of agricultural lands to wetlands) and which of the three groups is included in the analysis.

From a continental perspective, the results of the analysis suggest that additional drainage of wetlands in either of the two study areas is not warranted. Furthermore, substantial benefits could be gained by allowing some agricultural areas to evolve back into wetlands.

From a national or provincial perspective, the same general conclusions about wetland conservation and re-establishment apply. The only exception is that, in the Lost River Study Area, it would not make economic sense to allow agricultural lands to revert to wetland conditions as the value of lost agricultural production exceeds the value of those wetland functions that have been quantified in this study.

From the farmers' perspective, the results suggest that, under current conditions, there is little financial or economic incentive to undertake additional wetland drainage, except on the very best lands. However, it must be recognized that there are a variety of incentive and subsidy programs in place which distort the balance of benefits and costs such that wetland drainage appears economically attractive. (Some of these barriers are described in Section 6.4). Thus, a small portion of farmers in each of the study areas, especially the Lost River Study Area, are planning to undertake additional wetland drainage in the near future.

It is also not in the farmers' best interest to allow agricultural lands to revert to wetlands for a variety of reasons (subsidies, incentives, etc.) unless sufficient compensation could be offered to offset the lost value of production. As determined earlier, this compensation would have to be on the order of $65 to $111 per hectare, depending on the study area and agricultural capability of the soils.

Despite the large social benefits that can be attributed to wetland conservation and re-establishment, it is very difficult to promote provincial or continental interests to farmers who, in most cases, have ownership of the wetland resources and perceive a loss of potential revenues. As noted by Turner *et al.* (1987):

> Though a landowner may be cognizant of the societal or external values of wetland habitats, such concerns are usually preempted by his on-farm costs and benefits when the fate of a wetland is being considered. These benefits rarely convey tangible benefits to the landowner, but instead represent an impediment to increased production and the source of higher operational costs.

Herein lies the dilemma of wetland conservation: wetland development may be good for individual farmers but represents a greater cost to society at large, yet the farmer makes the decision about whether to drain wetlands. How then do we reconcile the interests of individual farmers with the conflicting interest of society at large?

The answer to this apparent dilemma, from an economic perspective, is simply to have society compensate the farmers for the revenues that they would otherwise earn from draining and cultivating wetlands. In this way, wetlands would be preserved and, as long as the benefits of conservation exceed costs of compensation paid to farmers, everyone would benefit. However, given that some of the benefits of wetland conservation are spread over multiple political jurisdictions, that these benefits fall outside the conventional market-place and that there is no mechanism whereby benefits and costs can be balanced and redistributed, the payment of compensation to farmers for wetland conservation is not a simple matter.

6.3 INCENTIVES FOR WETLAND CONSERVATION

Having determined that, for typical wetlands in the Rural Municipalities of Lost River and King George, conservation usually represents a better use of wetlands to society than does agricultural development, the question then becomes how to provide incentives (or compensation) to landowners so that wetland conservation can be in the best interests of everyone? At the present time there are a number of such programs in Saskatchewan that reflect society's burgeoning interest in wetland habitat conservation. Some of these are examined briefly below.

6.3.1 Prairie Pothole Project

This project was initiated in 1986 by Saskatchewan Parks and Renewable Resources with funding by Wildlife Habitat Canada for the purpose of designing and implementing a program which would secure long-term protection of small, privately-owned wetlands and associated upland nesting cover in agricultural Saskatchewan. Based on a survey of landowners in the Redvers area in southeast Saskatchewan, the first phase of the study determined that leasing of upland and wetland habitat for waterfowl to a wildlife agency was the preferred habitat retention option, and $25 per hectare ($10 per acre) of pasture land was considered to be a reasonable annual lease fee. To secure long-term leases, a sliding fee schedule was then proposed, jumping from an annual fee of $30 per hectare ($12 per acre) for a 10-year lease to $49 per hectare ($20 per acre) for leases of 20 years or more. Other habitat retention options included financial support for farmers to adopt wildlife-compatible farming techniques and property tax relief, but these were favoured by a very small number of landowners.

Implementation of the project started in 1987 and, by February 1988, leases covering about 5 666 ha (14 000 acres) of habitat were under agreement. For the most part, upland habitat was considered to be the most important limiting factor for waterfowl production so that upland areas with adjacent wetlands were targeted. Lease agreements pertained mainly to upland areas, with a restrictive caveat being placed on wetland degradation. The actual leases offered to landowners were either five or 10 years in duration and ranged from $25 per hectare ($10 per acre) per year for pasture land to $62 per hectare ($25 per acre) for cultivated land taken out of production. During the lease negotiation process, it was found that only 10 percent of landowners were interested in leasing cultivated lands for $62 per hectare ($25 per acre) and, even when the lease fee was increased to $74 per hectare ($30 per acre), this percentage only increased to 11 percent.

The results of this pilot study enable a critical evaluation of the Prairie Pothole Project. As the project targeted lands with potential upland habitat for waterfowl, the potential annual value of agricultural production from such lands would be quite large - $111 per hectare in the Lost River Study Area and $65 per hectare in the King George Study Area. In light of these values, it is not surprising that participation in the program was quite low when lease fees of $62 per hectare were being offered and increased only slightly when raised to $74 per hectare. These lease fees do not adequately compensate farmers for the loss of net revenues that would result, particularly for the more productive lands in the Lost River Study Area.

And, since the extent or values of wetland areas were not included in the annual lease payments being offered, the program implicitly assumes these areas have no value to farmers. As described earlier, however, it was determined that half of farms with wetlands did use these areas for some form of agricultural purpose. For this reason, the annual compensation (lease) offered under the Project is inadequate to offset the benefits that farmers would have to forego if they decided to participate in the Project. This may also help explain why very few of the farmers contacted agreed to participate in the Prairie Pothole Project.

Overall the results of the Prairie Pothole Project clearly demonstrate that, in order to be successful, any compensation or incentive payments must at least reflect the net agricultural capability of the land.

6.3.2 North American Waterfowl Management Plan

A second incentive program for wetland conservation is the North American Waterfowl Management Plan (NAWMP) which has been developed to enhance waterfowl habitat and increase the population of Mallards by 85 percent over current levels. The proposal calls for spending of $438 million over 15 years and will affect approximately 2.3 million hectares (5.7 million acres) of land. Programs to be funded under the plan include on-farm demonstration and land procurement through purchase or lease plus the development of nesting structures and fenced and unfenced nesting cover. Both the Lost River and King George study areas fall within key program areas for NAWMP programs, being located in the Allan-Tiger-Minichinas Hills Program Area and Missouri Coteau Program Area, respectively.

With respect to procurement programs, NAWMP will implement programs to pursue the following objectives:

- return cultivated marginal agricultural land (CLI classes 4, 5 and 6) to permanent cover, mainly through 15-year leases. Target: 116 000 hectares (286 530 acres). Budget: $107.4 million;

- encourage the conversion to permanent nesting cover of cultivated land adjacent to wetlands and in odd-shaped inter-pothole areas that are inconvenient to cultivate. Target: 730 000 hectares (1.8 million acres). Budget: $62.6 million;

- establish hayland on currently cultivated lands (CLI classes 1 to 4) and ensure harvest occurs after duck nests have hatched. Target: 4 580 hectares (11 320 acres). Budget: $3.8 million;

- delay of harvesting on existing haylands so that most duck-nests can hatch. Target: 45 660 hectares (112 780 acres). Budget: $15.5 million;

- lease and manage haylands in intensively-farmed areas. Target: 22 830 hectares (56 400 acres). Budget: $10.5 million;

- lease and manage pasture lands for upland nesting cover. Target: 201 480 hectares (497 670 acres). Budget: $93.1 million; and,

- management of publicly-owned pastures for duck production. Target: 161 540 hectares (399 000 acres) Budget: $1.3 million.

According to the implementation plan, NAWMP will affect 19 percent of cultivated lands, 30 percent of hayland and 49 percent of pasture lands in the key program areas.

Again, NAWMP adopts the position that upland areas are the limiting factor, with the result that acquisition of wetland areas is not specifically addressed in the Plan. Upland areas adjacent to wetlands are targeted by the Plan, with upland areas being leased from farmers and restrictive caveats being placed on wetland degradation.

While implementation of this program is yet to occur, details of the plan indicate that maximum expenditures to acquire cultivated land will be about $926 per hectare over 15 years (or $62 per hectare per year) compared to $462 per hectare for pastureland and hayland ($30 per hectare per year). These prices are considerably less than the annualized agricultural benefits of about $111 per hectare ($50 per acre) that farmers in the Lost River Study Areas would receive from cultivation and it is unclear how many hectares of upland habitat could be secured in this area based on these lease fees. However, NAWMP has targeted lands with moderate to poor agricultural capability so that annual lease fees on the order of $62 per hectare may be more effective in the King George Study Area where annual net revenues from agriculture are about $65 per hectare.

It must be noted, however, that NAWMP does not include any funds for leasing of actual wetland areas and, given that farmers currently derive some benefits from wetlands, the lack of compensation for loss of these benefits may also limit the effectiveness of NAWMP.

Another noteworthy aspect of NAWMP relates to funding. As a continental waterfowl management program, NAWMP is being funded by governments in both Canada and the United States in recognition of the fact that wetland and waterfowl habitat projects in Canada will benefit residents of the United States. The proposed funding arrangement of 75 percent from the U.S. and 25 percent from Canadian sources is quite similar to the distribution of waterfowl hunting benefits between Canadian and U.S. hunters as determined in Section 4.2.3 of this analysis.

If NAWMP does succeed in increasing Mallard populations according to plan, it is likely that the social benefits of wetland conservation will increase accordingly. NAWMP focuses on management of nesting and land habitat rather than actual wetland habitat so that the extent of wetlands will not increase as a result of the plan. But, with more ducks per hectare of land, the amount of available wetlands may eventually become the limiting factor for duck production. As such, wetlands will undoubtedly increase in value faster as a source of waterfowl habitat and other wetland functions than as a source of agricultural benefits.

6.3.3 Discussion

The Prairie Pothole Project and the North American Waterfowl Management Plan are just two of the best-known wetland and upland habitat conservation programs being developed in Saskatchewan at the present time. Other examples include the Wildlife Development Fund and the Heritage Marsh Program. In all cases, the role of these programs is to provide incentives to landowners to manage their resources in the best interests of society. These incentives are expected to compensate farmers for the loss of income that they could otherwise receive from both upland and wetland areas.

The adequacy of these programs remains to be seen. The lease fees being offered to farmers for upland areas appear to be below the potential income that could be derived from agricultural production for typical farms in the Lost River Study Area but may be adequate for lands with moderate to poor agricultural capability, such as in the King George Study Area. Further analysis regarding the relative values derived from wetlands and agricultural lands having different capabilities will have to be undertaken before the exact trade-offs between conservation and development of wetlands can be determined.

6.4 BARRIERS TO WETLAND CONSERVATION

While the foregoing analysis demonstrates recent initiatives designed to encourage conservation rather than development of wetland and adjacent upland resources, there are still a number of programs and policies that encourage wetland drainage, even though this does not appear to be in the best interest of society at large. Some of these barriers to wetland conversation are described below.

6.4.1 Economic Barriers

A recent assessment of the various economic barriers related to wetland conservation was undertaken for Wildlife Habitat Canada (Girt, 1990). This assessment identified three major types of farm support programs which, in one way or another, encourage agricultural practices which adversely affect wetland conservation.

- farm income support programs which protect and stabilize farm incomes from short-term declines in prices or crop yields. These include such things as crop insurance programs where farmers pay only a portion of program costs and can benefit by increasing the land area under production in order to qualify for higher support payments;

- farm input subsidies where governments pay for some portion of the real cost of transportation fuels, fertilizers, and land improvement. By reducing on-farm costs, farmers realize a higher net return per hectare and are often encouraged to clear and cultivate additional acres; and,

- market policies and programs, such as marketing boards and the assignment of quotas, provide on-farm support that would not otherwise be available. For example, grain delivery quotas are tied to land areas under production and additional quotas can be acquired by expanding the land area under production. According to various analysts (Sawatsky, 1979; Bond *et al.*, 1986; Quota Review Committee, 1988; Esquirol, 1988), if farms want to increase their grain quotas, the existing market creates a strong incentive for farmers to drain wetlands in order to expand their agricultural land base.

The cumulative effect of these economic barriers can be quite large. Estimates taken from various sources (Girt, 1990) suggest that, for a recent five-year period, the annual subsidies paid to Saskatchewan grain farmers were about $106 per hectare ($43 per acre) of cultivated land, with about one-third of this amount being due to the recent trade war in grain. If the effects of these subsidies were to be incorporated into the benefit/cost comparison in Table 43, the benefits of increased wetland drainage from the perspective of the farmers would outweigh the potential social benefits of wetland conservation in most cases. Thus, the economic factors listed above represent very significant barriers to wetland conservation.

One other economic barrier not explicitly mentioned by Girt is provincial taxation procedures. When land is assessed for tax purposes, a value is typically ascribed to wetlands and other unimproved lands. From the farmers' perspective, these areas represent a tax liability and, as such, are often developed in order to generate some offsetting revenues. In both Canada and the United States (Odum, 1983), analysts have called for modification of taxation procedures in order to create a tax incentive to conserve wetlands and other natural areas. In Alberta, a "net income" approach that will tie tax assessments to soil capability, tree cover and anticipated net income, rather than total area under cultivation, has been developed for implementation in the late 1990's and this approach will no longer encourage wetland drainage[17].

6.4.2 Attitudinal Barriers

A number of authors have determined that the attitudes of farmers and resource managers can often provide a barrier to wetland conservation. For example, Sawatsky (1979) noted that "there is a pervasive notion that elaborate drainage works are essential throughout the agricultural portion of Manitoba" yet there is no meteorological data which indicates excessive moisture conditions. Based on the results of the survey, farmers in Saskatchewan appear to be less convinced of the need for wetland drainage, but it is not clear whether the same change in attitude has occurred in the minds of all water managers.

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[17] Environment Council of Alberta (1989). "New Rural Tax System to Benefit Habitat" in Alberta Conservation Strategy Update. November, 1989.

In a similar vein, Young (1989; page 12) notes that:

> For generations, the landowner has been encouraged by governments and society that it was in the public's best interest to pursue certain agricultural goals, frequently at the expense of the long-term health of the landscape. Changes in societal values with respect to economic implications and environmental integrity have recently caused a re-thinking of this approach. It is perhaps unreasonable to expect the farmer to dramatically adjust his/her attitudes toward farming practices in response to only recently expressed societal interest in environmental issues.

Thus, there appears to be a need for increased awareness by farmers and landowners of wetland functions and their benefits to society before all of the potential benefits of wetland preservation initiatives can be attained.

7.0 SUMMARY AND CONCLUSIONS

7.1 INTRODUCTION

As one of four pilot studies completed across Canada, this project has generated two different types of information regarding wetland management. First, the analysis provides some important information regarding the use of prairie pothole wetlands located in the Lost River and King George Study Areas in south central Saskatchewan. Second, and more importantly, the analysis has demonstrated a methodology whereby the social benefits from wetland preservation can be incorporated into decision-making. A summary of the findings for each aspect of this analysis is provided below.

7.2 WETLAND MANAGEMENT

From the perspective of wetland management, the overall conclusion to be drawn from this study is that prairie pothole wetlands are definitely not wastelands. Pothole wetlands provide a variety of functions which benefit society at large. For typical wetlands in the two study areas, these social benefits usually outweigh the benefits that landowners could realize through wetland drainage and subsequent cultivation. To best manage wetlands in the public interest, then, wetland preservation must be given priority in resource management decisions and practices. However, if landowners are to be dissuaded from wetland drainage, greater incentives to conserve wetlands will have to be offered if the existing stock of prairie wetlands is to be maintained or expanded, and current agricultural programs which promote wetland drainage will have to be eliminated.

In arriving at this overall conclusion, a number of important secondary conclusions were derived. These include the following:

1) the most significant functions for wetlands in the two study areas included groundwater recharge and soil moisture enhancement, waterfowl habitat, and their use as recreational resources;

2) of the various functions for wetlands in the two study areas, those related to recreational activities were the easiest to quantify both in terms of use and value. This limited range of wetland functions was the focus of the methodology adopted in the study;

3) from an agricultural perspective, wetland drainage provides two types of benefits: expansion of the area available for cultivation (primary benefit) and improved efficiency of farming on the adjacent uplands. For typical farms in the Study Areas it was found that the efficiency benefits were equivalent to between 60 to 90 percent of the primary benefits, although efficiency gains could be much larger than this if wetland drainage allows farmers to start farming operations earlier in the season. On the other hand, where wetland areas can still be found on farms, about half of the farmers use these areas a source of forage or water supply and these benefits would be foregone as a result of wetland drainage;

4) for a typical 1.5-section farm in each of the two study areas, additional wetland drainage does not make much economic sense. In most cases the short-term costs of wetland drainage would more than offset the primary and efficiency benefits by between $22 and $71 per cultivated hectare per year. Were substantial increases in efficiency benefits to be realized, net positive returns could be realized on farms in the Lost River Study Area, which has more productive soils, but these would not be adequate to offset interest costs if farmers had to borrow money to finance the initial drainage and development costs. This analysis excluded subsidies and other economic

support for farmers which could amount to as much as $106 per cultivated hectare per year and would make wetland drainage appear more attractive;

5) wetlands in the two study areas are important waterfowl habitat and fulfil a broad range of habitat requirements. The average density of ducks was determined to be 0.62 ducks per hectare of land or about 5.9 to 8.6 ducks per hectare of wetland;

6) waterfowl dependent on wetlands in the two Study areas generated about 3 075 days of hunting in Saskatchewan plus substantially more hunting opportunities in the United States. The benefits associated with these activities amount to at least $0.8 million per year, based on what a resident hunter would be willing-to-pay to continue to hunt waterfowl produced in the Study Areas. If hunters had been asked how much compensation would be required for them to forfeit these hunting benefits, the resulting values would have been at least twice as large. Benefits to Canadians accounted for about 15 percent of the total;

7) about five percent of households in southern Saskatchewan use wetlands in the two Study Areas for recreational purposes such as viewing scenery, hiking and bird watching as well as hunting. Annual recreational activities amount to about 110 900 user-days including hunting, of which 15 percent is by regional residents. The annual benefits derived from these recreational activities amount to at least $0.5 million based on a conventional willingness-to-pay evaluation methodology. Due to small sample size and a high variation in results, these estimates are not particularly accurate and should be used with caution;

8) about 42 percent of households were willing to pay into a fund devoted to wetland conservation and protection in Saskatchewan. An average annual

payment of about $42 was reported and this would generate about $6.5 million in total. These existence values are equivalent to at least 25 percent of the user benefits reported by wetland users;

9) the total annual recreational benefits attributable to wetlands in the two Study Areas were at least $1.4 million. This is equivalent to between $156 and $249 per hectare of wetland, with the higher values associated with the King George Study Area. Saskatchewan benefits account for about 47 percent of total benefits or between $68 and $136 per hectare. The remaining benefits would accrue to hunters in the United States;

10) from a provincial perspective, the social values resulting from the recreational use of wetlands exceeds the returns that farmers would receive from additional wetland drainage. Conversion of wetlands to agricultural lands would result in annual losses of potential recreational benefits of between $100 and $200 per hectare. These losses would likely be higher if the benefits attributable to other wetland functions were to be incorporated into the analysis;

11) if a continental perspective is adopted, the economic arguments against further wetland drainage are even more compelling. For each hectare of additional wetland drainage, the net loss to society would range from about $180 to $320 per year;

12) the analysis also suggest that, in areas having lower soil capability, it is socially efficient from a provincial perspective to allow some existing agricultural areas to revert back to wetlands. In the King George Study Area, for example, the provincial recreational benefits would exceed the value of agricultural production by about $71 per hectare on an annual basis. On the other hand, the agricultural benefits of cultivated land in the Lost River Study

Area outweigh the potential recreational benefits to provincial residents by about $43 per hectare per year, but this position would be reversed if the potential benefits to U.S. hunters were to be considered;

13) if wetlands are to be protected or conserved, current landowners will have to be compensated for the loss of potential revenues from alternative uses of these wetland areas. In the case of existing wetlands there appears to be little financial incentive to farmers to undertake additional drainage (excluding the effects of subsidies), but a rigorous approach to conservation may preclude current wetland use for agricultural purposes (i.e. forage production). Existing wetland conservation programs do not appear to address these potential on-farm losses;

14) if existing agricultural lands are to be taken out of production in order to provide upland habitat or to allow lands to revert back to wetlands, compensation to land owners must reflect the value of agricultural production foregone. These values were determined to be $111 per hectare in the Lost River Study Area and $65 per hectare in the King George Study Area. In contrast, lease payments currently offered under existing wetlands/habitat conservation programs offer only $62 to $74 per hectare with the result that participation in these programs may only appeal to farmers in areas of lower soil capability, such as in the King George Study Area.

7.3 THE WETLAND EVALUATION METHODOLOGY

While these findings may have important implications for the future management of pothole wetlands in the Canadian prairies, the primary objective of the study was to develop and test methods whereby the real social contributions of wetland resources could be better represented in resource management decisions. Unlike the previous three pilot studies, which each employed three different evaluation methodologies, the prairie potholes study employed an approach that incorporated all three methods:

> First, the so-called "multiple function matrix" was used to screen for important wetland functions in each of the study areas.
>
> Second, the relative benefits and costs of developing and preserving wetlands were evaluated in terms of the "opportunity costs" associated with each development scenario. (These opportunity costs were sometimes measured in terms of "willingness-to-pay" to maintain wetlands.)
>
> Third, these benefits and costs were compared using a simple benefit/cost analysis format to identify the optimal use of wetlands from a social perspective.

Judging from the results, which show that the values derived from wetland functions are significant and that conservation represents the optimal use of remaining wetlands on typical farms in the two study areas, this methodology must, in general terms, be considered a success. Previous concerns with the adequacy of benefit/cost analyses as an adequate decision-making tool for assessing environmental issues appear to be unfounded, so long as the analysis attempts to incorporate the full range of social benefits and costs, rather than address only market-derived values. While the analysis was able to evaluate only a limited range of wetland functions, the results adequately demonstrate the importance of preserving prairie pothole wetlands.

This is not to say that the evaluation methodology is not without some important limitations. A general problem with pilot studies is the extent to which their findings may be generalized to a larger geographical area or slightly different problem situation. In this instance, the model has been used to assess the trade-offs between wetland development and conservation for typical farms in the two study areas but, in practice, the conclusions may not necessarily apply to wetlands areas on non-typical farms, to farms outside the two Study Areas, or even to a specific farm or wetland within either of the two areas.

With regard to the specific methodology employed in this study, the multiple function approach was of considerable assistance as a mechanism for screening the full range of wetland functions to determine which of these were relevant to the prairie pothole wetlands and warranted further research. While this method provided a useful mechanism for identifying and summarizing the various benefits of wetland conservation, it was of limited analytical use since it lacked the rigour and common evaluation units necessary for easily and clearly establishing the trade-offs between conservation and other wetland uses. For this reason, the multiple function method was used in combination with benefit/cost analysis to produce a workable and effective method for evaluating the optimal use of prairie pothole wetlands.

A second limitation of the evaluation method employed in this study is that, while it was possible to identify functions which are characteristic of wetlands in each of the study areas, it was impossible to assess the significance and role of all of these functions let alone quantify them in economic terms. For example, the screening process identified various hydrologic functions for wetlands in the two Study Areas yet it was not possible to incorporate the value of these functions into the benefit/cost analysis. Fortunately, the quantifiable values were able to make a strong case for wetland conservation. But had the recreational benefits not been very large, the results of the analysis could have been quite different unless some of the other important wetland functions could have been readily quantified. To remedy this data deficiency, more data collection and research into the significance of other wetland functions will have to be undertaken.

Similarly, even fairly basic information on well-established wetland functions is inadequate. As an example, most of the conservation benefits are tied to waterfowl harvest data which are based on one estimate of the average waterfowl productivity for the region and crude estimates of the Canadian/U.S. harvest of waterfowl and associated benefits. While this information may be adequate on a provincial basis, more detailed and current information is required if specific wetlands or wetlands in other regions are to be assessed.

It should also be noted that the analysis has been conducted on the basis of "typical" wetlands in each of the study areas. Given that different types of wetlands provide different functions, the results of the analysis may not be applicable to wetlands in any other area or to specific wetlands. This concern is particularly important in that, from the perspective of waterfowl production, a mix of wetland habitats is required to fulfil the full range of habitat requirements.

A third and related problem is that where wetland functions could be quantified, the resulting estimates are too unreliable to serve as the basis for rigorous analysis of alternative uses of wetlands. Part of the uncertainty associated with these estimates developed in this study is due to the small sample size, large variability and potential for bias inherent in the survey results. More reliable estimates can only be developed by larger, more comprehensive surveys. However, the cost and timing of such a survey will add to the difficulty in defining a technically-acceptable and consistent wetland evaluation procedure and this may, in turn, limit this type of analysis to large-scale projects, programs or policies.

There is also concern over the method used to evaluate the non-market values associated with certain wetland functions. As discussed earlier, the recreational value of existing wetlands should more correctly be determined in terms of the amount of compensation required so that hunters and other recreationists would choose to forego recreation in a specific wetland area. However, the estimates used in this analysis are based on willingness-to-pay since there is as yet no proven, reliable method for measuring willingness-to-sell. For this reason, the recreational values provided in this analysis may severely understate the extent of social benefits provided by wetlands.

A similar set of problems arose during estimation of the potential benefits of draining wetlands for agricultural purposes (opportunity cost of wetland conservation). The results of the analysis showed that land capability for agriculture plays an important role: lands with high capability will generate more direct income for farmers (therefore meaning higher opportunity costs) than will lands with lower capability. While CLI data are available to identify agricultural capability, there are insufficient site-specific data relating to crop yields and farm operating expenses with which to assess the potential economic benefits of wetland drainage on lands with different agricultural capabilities. In addition, it is very difficult to isolate the effects of price and input subsidies for agriculture so that the correct measure of the social value of increased production cannot be determined with complete accuracy.

Another shortcoming of the agricultural analysis was lack of region-specific information about the magnitude of the efficiency benefits associated with wetland drainage. While this analysis adopted some of the results of research done in the Peace River country in Alberta, it became evident that not all of the various efficiency benefits identified in this research applied to the prairie pothole region. To accommodate some of the uncertainty related to these benefits, especially the effects of improved timing of agricultural operations, various assumptions were employed. And, until further research on the nature of efficiency benefits from wetland drainage in other locations can resolve this uncertainty, the use of sensitivity analysis will remain an important component of the overall evaluation methodology.

Overall, it can be concluded that the combined use of the multiple function method and benefit/cost analysis provides a useful and consistent procedure for assessing a broad range of environmental issues, including wetland conservation. The main limitations of this procedure remain a lack of information about the full range of wetland functions and reliable estimates of the benefits that wetlands can provide. And, while the results of this analysis show that, on a generic basis, conservation represents the most socially efficient use of wetland resources on typical farms on the two Study Areas, these conclusions may not apply to individual wetlands due to differences in agricultural and habitat capability and the provision of a different mix of wetland functions. An important conclusion of this study is that it is very difficult to generalize about the social value of wetlands. And, with the passage of time, one could reasonably assume that wetland values will increase as the number and diversity of wetlands decreases.

The success of applying the suggested evaluation methodology to address wetland conservation issues across Canada will ultimately depend on more and improved information about the importance of the various roles played by different wetlands values. At the present time, a similar tool is being developed for wetland management in northwestern Alberta as part of the Subbasin Water Management Planning Program (SWMPP) is being developed by Alberta Environment. And, in terms of the results of this pilot study, documentation of the trade-offs between the benefits to farmers of wetland drainage and the benefits to society of wetland conservation represents a useful description of the dilemma of wetland management. For these reasons, this study represents a useful educational tool which provides both decision-makers and the public at large with a better understanding of the overall problem and the important roles that wetlands play. This may, in turn, lead to adjustments in existing programs which foster wetland development and replacement with new programs designed to encourage wetland protection and conservation.

The results of the analysis also provide some useful insights into the successes and failures of existing wetland conservation programs. Without knowing the economic realities of the wetland issue, it has been difficult to design and implement successful wetland conservation programs. However, by conducting this analysis, it is now evident that the size of incentives to landowners to encourage wetland conservation will have to be increased if these programs are to be successful. Most programs have considered a lack of upland habitat as the limiting factor for waterfowl production and have treated actual wetlands as having little value to farmers. The results of the surveys have shown that farmers do indeed benefit from wetlands, through forage production and as a water source, so that some form of additional compensation will have to be provided if farmers are to be encouraged to leave wetlands in a natural state. Furthermore, the analysis indicates that lease payments of $62 to $74 per hectare may not be adequate inducement for farmers to forego agricultural production in favour of creating upland habitat, especially in areas having high agricultural capability. Thus, if the habitat conservation/protection targets of existing programs are to be achieved, it may be necessary to increase lease payments in order to better reflect the opportunity cost of agriculture on lands with moderate to good wetland capability.

7.4 WETLAND REFERENCE GUIDE FOR PLANNERS AND DECISION-MAKERS

One last aspect of this analyses relates to one of the long term objectives of the "Wetlands Are Not Wastelands" project which is to develop a reference guide for planners and decision-makers. The purpose of such a guide will be to provide a methodology whereby planners and decision-makers can make better-informed decisions about the best use of renewable resources such as wetlands. Such a methodology will require consideration of a broader range of environmental and social values than might normally be addressed and will employ a three-stage system whereby successively more complex evaluation procedures can be employed, as required, to arrive at decisions about renewable resources.

In developing this guide, the prairie pothole study is important for a number of reasons:

- first, it demonstrates the need for undertaking this type of analysis. Whereas wetland drainage and cultivation have often been considered as the best use of wetlands, this study demonstrates that this may no longer be the case, especially if a continental perspective to resource management is adopted;

- second, it provides an example of how the three-staged evaluation methodology can be employed. As employed in the prairie pothole study, the methodology includes:

    1. a quick screening process which allows identification of the most important biophysical and socio-economic attributes of wetland resources;

    2. the use of a multiple function evaluation process which comprehensively assesses the relative importance of the various functions in qualitative terms; and

    3. if the best use of wetlands has not yet been determined, the use of a social benefit/cost analysis wherein a quantitative assessment of the various alternative uses of wetlands is undertaken.

- third, it identifies the types of information that planners and decision-makers will require to use this methodology. As demonstrated in the foregoing analysis, there is at present insufficient information on either the nature of wetland functions or their economic contributions to society to warrant using either a multiple function evaluation process or a benefit/cost analysis. Thus, the analysis clearly shows the need for additional research on basic environmental values if the proposed methodology is to be effectively employed.

Similarly, the analysis also demonstrates some of the potential difficulties and biases inherent in using existing information, particularly in regard to assessing the opportunity costs of wetland conservation. For the agricultural industry, for example, product and input prices do not necessarily reflect the real costs or benefits to society at large and thereby represent a significant barrier to wetland conservation and other aspects of achieving sustainable development.

- fourth, it provides an opportunity for agencies and organizations currently involved in wetland conservation/protection programs (like NAWMP and the Prairie Pothole Project) to analyze the potential effectiveness of their programs. Such information may be of assistance in identifying wetlands that are at greatest risk and in developing criteria for allocating financial resources to achieve better results.

While recognizing that such a reference guide may be of considerable value to planners and decision-makers, it must be remembered that the fate of wetlands will ultimately rely on the actions of landowners in many cases. For this reason, it will be important to make landowners more aware of the environmental and social implications of their actions; the results of the prairie pothole study may be of assistance in this regard. Ultimately, the fate of some wetland resources may depend upon creating incentives for landowners not to drain them for private gain but to act in the best interests of society at large, and by employing benefit/cost analysis, the extent of these compensation requirements may be better estimated.

While generally supportive of the development of a reference guide, the results of this pilot study must be used with caution, however. Estimates of the values associated with both wetland conservation and agriculture development are incomplete and highly variable and pertain only to wetlands on typical farms in the two study areas at this point in time. The values should not be adopted for use in evaluating other resources management decisions since values are known to vary considerably among locations and over time. If the proposed evaluation methodology is to be used correctly and to maximum advantage, the relative benefits and costs of renewable resource development will have to be examined on a case-by-case basis.

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APPENDIX I

PRAIRIE POTHOLE STUDY:

SURVEY METHODOLOGY AND QUESTIONNAIRE

APPENDIX I

PRAIRIE POTHOLE STUDY - SURVEY METHODOLOGY

The prairie pothole study was different from the other three case studies where various wetland evaluation methods have been employed. The major difference was that the two study areas, while individually quite large, are both small parts of the overall prairie wetland complex. For this reason, use of the study areas for recreational and other reasons was expected to be relatively minor. Whereas the surveys conducted for the other three case studies had a relatively high probability of encountering people who had knowledge of and had used the wetlands in question, this was not expected in the case of the prairie potholes.

For the proposed survey of prairie pothole wetland functions and value to be of some use, it was decided that the survey design should be modified to reflect a provincial perspective rather than focus solely on the two study areas. Questions pertaining to wetland areas in southern Saskatchewan were included so that the probability of contacting respondents with knowledge of wetland function and value would be higher than if the survey were restricted to use of the two study areas. This was implemented to make the survey more cost-effective. Specific questions about wetland values in the two study areas were also be posed in order to collect some information about their importance and value relative to Saskatchewan wetlands in general.

1.0 SURVEY POPULATION

To undertake this survey, the sample was designed to address three specific populations:

1. All households in southern Saskatchewan. This area was defined to include those parts of Saskatchewan considered to be grasslands or farmland. In general terms, this would include lands south of a line following the North

Saskatchewan River from the Alberta border to Saskatoon, east to Quill Lake, south to Regina and then along the Trans-Canada Highway to the Manitoba border. For survey purposes, this translated in Census Districts 1 to 8, 11 to 13 and parts of 10 and 17. The total adult population of this area consists of about 690,000 people.

2. All households within a 15 - mile (24 - kilometre) radius of the Rural Municipality of Lost River. Based on 1986 census data, this includes about 4,255 households and 12,600 people.

3. All households within a 15 - mile (24 - kilometre) radius of the Rural Municipality of King George. This includes 4,945 households and 13,710 people.

2.0 SAMPLE FRAME

The frame for the sampling procedure was selected to be all households that reside within the designated areas and have residential telephone service. The population of households was determined using census information.

Households were chosen as the basis for sampling because the sample extrapolation process is easier and there was a higher probability of making a successful contact during the survey process than if specific individuals within a household were targeted. Given the budget and time limitations for the survey, this consideration was very important. While using households as the survey unit helps to ensure that the sample results are representative of the population in terms of various household characteristics, the respondent selection process within households was neither random or systematic so that survey responses reflecting individual opinions and information may not be entirely representative of the population.

The actual selection of the sample for the provincial-level survey employed the "one-plus" system. This system involved the selection of telephone numbers at random from the published telephone directories for the survey area. The sample was then adjusted by adding one digit to each of the sample of telephone numbers generated. This system ensured the randomness of the sample and ensures that all new, changed and unlisted numbers in the population have an equal chance of being selected. As telephone companies tend to issue residential telephone numbers in groups, this process also minimized non-active, not-in-service contacts. While this sample included some households located in the two specific study areas, care was taken to ensure that these households would not also be included in the regional surveys.

For the two small study areas some problems existed because of overlaps in the telephone exchanges. Consequently, the list of random telephone numbers had to be checked against the residence location in order to determine whether the household fell within the study area boundary. In these cases systematic sampling was adhered to in order to avoid extending beyond the study area.

3.0 Sample Size

The survey design called for completion of at least 200 interviews with a random sample of households from Southern Saskatchewan, plus 100 interviews with households in areas adjacent to each of the study areas. This level of coverage was chosen for two reasons. First, this same level of sampling intensity was consistent with the other three case studies and was used for estimating the approximate cost of the survey component of the work program. Second, the higher sample size (200) was adopted for the survey of households in southern Saskatchewan because of the higher probability of encountering wetland users. The smaller sample size was adopted for the two study areas because of a low incidence of users for these particular wetlands and because it was decided to assess the importance of these areas in relative, rather than absolute terms.

During implementation, it was determined that sufficient budget was available to increase the sample size. In order to add to the statistical validity it was decided to increase the sample size for the provincial survey to 245 and leave the regional sample size at 100 each.

4.0 INTERVIEW PROCEDURE

During the survey, it was anticipated that some individuals would refuse to complete the survey. Interviewers were asked to determine the reason for this non-compliance before terminating the interview.

It was expected that some households would not be contacted on the first attempt. To ensure that the randomness of the sample was maintained, three attempts were made to contact each household before it was replaced with another. Interviewers normally called between 6:00 pm and 10:00 pm on weekdays and between 10:00 am and 2:00 pm on Saturdays. Interviewers were also asked to vary their calls during these periods (ie. two on separate weekdays and one on Saturday) in order to maximize the chance of making contact with all households.

At the time of the survey, interviewers were be instructed to ask to speak to someone who could speak on behalf of the entire household and the role of this person (ie. husband, wife, parent) was recorded.

In total, interviewers attempted to contact about 1,262 different households in order to achieve 445 completed interviews. However, nearly half of these households (46 percent) could not be reached; either the number was no longer in service (five percent of cases) or no answer was received after three attempts (95 percent of cases). Thus, the effective sample size was about 662 households.

The overall response rate to the survey was about 67 percent, although this varied amongst survey groups. The highest completion rate was noted for the Rural Municipality of Lost River (74 percent) and the lowest was for the Rural Municipality of King George (64 percent). For the households in the southern Saskatchewan survey area, completed surveys were received from 66 percent of households that were contacted. A detailed description of the results of the survey program are provided below:

	Attempts	No Contact	Effective Sample Size	Completions	Refusals
King George	336	180	156	100	56
Lost River	251	116	135	100	35
South Sask.	658	287	371	245	126
TOTAL	1,262	583	662	445	217

Based on the resulting sample sizes, estimates of proportions (ie. what percent of households use wetland areas for recreational purposes) are accurate to at most + 5.2 percent at a 95 percent level of confidence for households in the southern Saskatchewan population. The corresponding confidence intervals for the survey data from the regional populations (sample size of 100) is at most ± 6.1 percent.

5.0 Data Analysis

To minimize coding problems, the questionnaire was designed to facilitate recording of respondent answers. Additional coding instructions were also provided to interviewers, especially in regard to the willingness to pay questions. Missing values have been ignored in the analysis, unless they represent a significant portion (greater than 25 percent) of the responses. All completed surveys were coded, reviewed for any obvious problems and a coding list for responses to open-ended questions was developed. The data was eventually built into a data file that was analyzed using the microcomputer version of SPSS (Statistical Package for the Social Sciences).

Telephone Number: | | | | - | | | | | |

	Month	Day	Time
First Attempt:			:
Second Attempt:			:
Third Attempt:			:

Interviewer:
Verification:
Comments:

PRAIRIE POTHOLES STUDY

Hello, I am conducting a survey on behalf of Environment Canada and Wildlife Habitat Canada and would like a few minutes of your time to answer a few questions about your use of and opinions about wetland areas - sloughs and marshes - in Saskatchewan. Your telephone number has been selected at random and we would very much appreciate your cooperation. The survey will take about 10 minutes to complete, and any information you provide will remain confidential.

FUNCTIONS AND VALUES OF WETLANDS

Wetlands in Southern Saskatchewan provide a variety of functions and services, including the following:

- controlling or providing protection from flooding
- improving water quality
- recharge of groundwater
- influencing local climate (like rainfall)
- preserving endangered species
- producing ducks, muskrats and other wildlife
- providing opportunities for hiking, walking, hunting and birdwatching
- shelterbelt benefits to adjacent lands and soil quality

1. Using a scale from 1 to 5, where 5 is very important and 1 is not important at all, how important is it to protect wetlands areas in Saskatchewan, and all the various functions that they provide, for this and future generations?

Not Important				Very Important
1	2	3	4	5

(Circle one and confirm)

2. Wetland areas, ground water supplies and waterfowl populations have declined dramatically on the prairies in the last two decades. Given this trend, what course of action do you think should be taken? (READ LIST: CHECK ONE)

- ○ Maintain the current balance between wetlands and agricultural land.
- ○ Allow continued agricultural development on wetlands.
- ○ Encourage actions that would protect and reclaim wetlands.

3. We are trying to determine the value of wetlands to Saskatchewan residents and your answer to the following question is extremely important.

Would you be willing to make a contribution each year to protect wetland areas in Saskatchewan for this and future generations?

IF NO: Why not? ______________________________

IF YES: How much would your household be willing to pay each year to a fund that would protect and preserve wetland areas in Saskatchewan? $|__|__|__|__| per year

What organization would be most appropriate to control such a fund to protect wetlands in Saskatchewan?
(READ LIST IN RANDOM ORDER; CHECK ONE)

- ☐ nature organizations
  (If yes: Which group?______________)
- ☐ local government
- ☐ the provincial government
- ☐ the federal government
- ☐ other (specify)______________________

QUESTIONS FOR ALL HOUSEHOLDS

4. Do you live in a village, town or city, or do you live on a farm, acreage or in some other rural setting?	○ Urban ○ Rural farm ○ Rural non-farm
5. At the present time, do you own, lease or rent any land used for non-residential purposes like farming or recreation?	○ No ○ Yes

IF NONE, GO TO QUESTION 16, PAGE 4

AGRICULTURAL USE OF WETLANDS

6. Approximately how many acres of land do you own, lease and/or rent?	☐☐☐☐ acres
7. How many acres are cultivated:	
- tame grass	☐☐☐☐ acres
- forage crops	☐☐☐☐ acres
- grain crops or summerfallow	☐☐☐☐ acres
8. How many acres are not cultivated:	
- native grassland	☐☐☐☐ acres
- bush/shrubland	☐☐☐☐ acres
9. Are there any wetland areas like sloughs or marshes on these lands?	○ Yes ○ No
IF NO, GO TO QUESTION 10	
Approximately how many acres of wetlands are there on these lands?	☐☐☐☐ acres
Do you use these wetland areas for any purpose? IF YES: For what purposes? ____________________	○ No ○ Yes
10. In the past five years have you drained any wetland areas for agricultural purposes?	○ Yes ○ No
IF NO, GO TO QUESTION 11	
What were your reasons for draining these wetlands?	(DO NOT READ LIST. CHECK ALL THAT APPLY)
- discourage presence of wildlife/hunters	....○
- to increase income/more farm land	....○
- to "clean up" weedy areas	....○
- to help eliminate grasshoppers/insects	....○
- incentives through assistance programs	....○
- increase ease of manoeuvering machinery	....○
- better visibility (to roads, fields)	....○
- equipment was in the area	....○
- remove water from flooded land	....○
- irrigation	....○
- control beaver problems	....○
Any other reasons (specify)	____________________
If a program was implemented to protect wetland areas in Saskatchewan, how much would this program have to pay you per acre each year to allow these wetland areas to return to their original state?	$☐☐☐☐ /acre

QUESTIONS FOR FARM AND RURAL HOUSEHOLDS

11. Do you cultivate any wetland areas during dry years?	○ Yes ○ No
12. Do you cultivate land right to the edge of wetlands or sloughs?	○ Yes ○ No
13. During the past five years have you drained any wetland areas on a temporary basis?	○ Yes ○ No
14. Do you plan to drain any wetland areas for agricultural purposes in the near future?	○ Yes ○ No

IF NO, GO TO QUESTION 15

What are your reasons for planning to drain these wetlands in the near future?	(DO NOT READ LIST. CHECK ALL THAT APPLY)
- discourage presence of wildlife/hunters	....○
- to increase income/more farm land	....○
- to "clean up" weedy areas	....○
- to help eliminate grasshoppers/insects	....○
- increase ease of manoeuvering machinery	....○
- better visibility (to roads, fields)	....○
- equipment was in the area	....○
- remove water from flooded land	....○
- irrigation	....○
- control beaver problems	....○
Any other reasons (specify)	________________
If a program were implemented to protect wetland areas in Saskatchewan, how much would this program have to pay you per acre each year to forego draining these wetlands?	$|__|__|__|__| /acre
15. In general, do you consider wetlands to be an asset or a nuisance for agriculture? Why?	○ Asset ○ Nuisance

RECREATIONAL USE OF WETLANDS

16. During the past 12 months, have you or any members of your household visited or spent time at or near wetland areas such as sloughs or marshes in Saskatchewan for recreational or other purposes, including wetlands on your own property?	○ Yes ○ No

IF NO, GO TO QUESTION 25 PAGE 7

RECREATIONAL USE OF WETLANDS

17. What were the primary reasons for visiting or spending time at these wetland areas?

(Read list)

○ Hiking/walking
○ Hunting
○ Bird watching
○ Viewing scenery
○ Other (specify) ______

18. On how many occasions during the past 12 months did you or members of your household visit or spend time at wetland areas?

|__|__| times

19. On a typical visit to a wetland area by you or members of your household:

- how far did you travel to reach the area? |__|__|__| kms
- how many hours did you stay? |__|__| hours
- how many households members would participate in a typical trip? |__|__| people

---

20. As part of this study we are trying to determine the value of wetlands to Saskatchewan residents. The following question is based on a hypothetical situation. Your answers are extremely important.

Imagine that you had to pay a daily entry fee every time you visited or spent time at any publically or privately owned wetland area in Saskatchewan, just as you pay entry fees for movies or sporting events. Earlier you said that your household visited wetlands on ______ occasions during the past 12 months.

How many daily visits to wetlands areas would you or members of your household have made during the past 12 months if you had each been required to pay:

$0.50 per day visit |__|__| visits
$1.00 per day visit |__|__| visits
$2.00 per day visit |__|__| visits
$5.00 per day visit |__|__| visits
$10.00 per day visit |__|__| visits
$15.00 per day visit |__|__| visits

What daily charge would have stopped you from visiting or spending time at wetland areas in Saskatchewan altogether?
$_______ per day visit

Note to interviewers: There is no intention to actually charge such fees. Also check to make sure that as the daily charges increase, the number of visits decrease; if not, confirm responses.

WETLANDS IN THE STUDY AREA

We are particularly interested in two regions in Saskatchewan where wetland areas, such as potholes, are quite common. These two regions include the Rural Municipality of Lost River, which is east of Blackstrap Lake Provincial Park and about 30 miles southeast of Saskatoon, plus the Rural Municipality of King George, which is west of Lake Diefenbaker, and about 80 miles northwest of Regina.

21. Are you familiar with either of these regions?	○ Yes ○ No

IF NO, GO TO QUESTION 25, PAGE 7

Which of these wetland regions?	○ Lost River ○ King George
22. On how many occasions during the past 12 months did you or members of your household visit or spend time at either of these wetland areas, for recreational or other purposes?	☐☐☐ times

IF NONE: GO TO QUESTION 25, PAGE 7

23. What were the primary reasons for visiting or spending time at these wetland areas? (Read list)	○ Hiking/walking ○ Hunting ○ Bird watching ○ Viewing scenery ○ Other (specify) __________

24. Again, imagine that you had to pay a daily entry fee every time you wanted to visit or spend time at any private or publically-owned wetland areas in either of these particular regions, but that all other wetland areas in Saskatchewan could be used for free. You just said that your household visited the Lost River or King George wetlands on ______ occasions during the past 12 months.

How many daily visits to wetlands areas in these regions would you or members of your household have made during the past 12 months if you had each been required to pay:

$0.50 per day visit	☐☐	visits
$1.00 per day visit	☐☐	visits
$2.00 per day visit	☐☐	visits
$5.00 per day visit	☐☐	visits
$10.00 per day visit	☐☐	visits
$15.00 per day visit	☐☐	visits

What daily charge would have stopped you from visiting the Lost River or King George wetlands altogether? $_______ per day

DEMOGRAPHIC CHARACTERISTICS

25.	Which of the following descriptions best applies to your household?	○ Single person ○ Couple With No Children ○ Couple With Children ○ Single parent family ○ Two/more unrelated adults ○ Two/more related adults ○ Other __________
26.	How many people normally reside in your houshold?	☐☐ people
27.	How many of these are under the age of 19?	☐☐ people
	How many are 19 to 34 years of age?	☐☐ people
	How many are 35 to 49 years of age?	☐☐ people
	How many are 50 to 64 years of age?	☐☐ people
	How many are over 64 years of age?	☐☐ people

THANK YOU FOR YOUR ASSISTANCE

APPENDIX II

REPRESENTATIVE MAP FOR THE LOST RIVER STUDY AREA

Lost River
Study Area
Twp 31 Rge 02

Legend

▩ Temporary and Seasonal Wetlands

▦ Semipermanent Wetlands

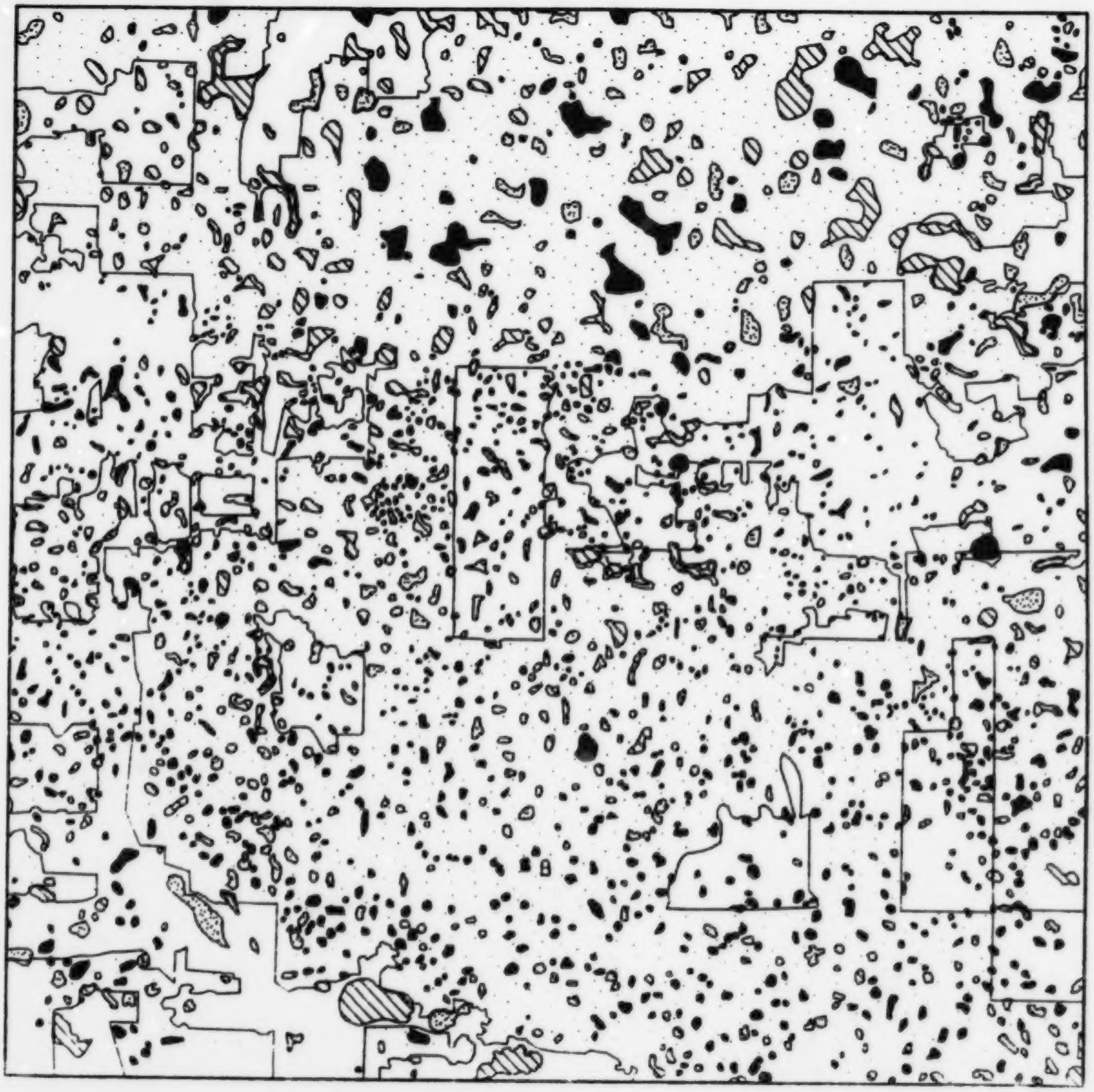
■ Permanent Wetlands

▧ Alkaline Wetlands

□ Pasture

⬚ Agriculture

Based on Summer 1979 1:56,000 Airphotos
Scale = 1:43,000 (Approx.)



APPENDIX III

REPRESENTATIVE MAP FOR THE KING GEORGE STUDY AREA

King George Study Area

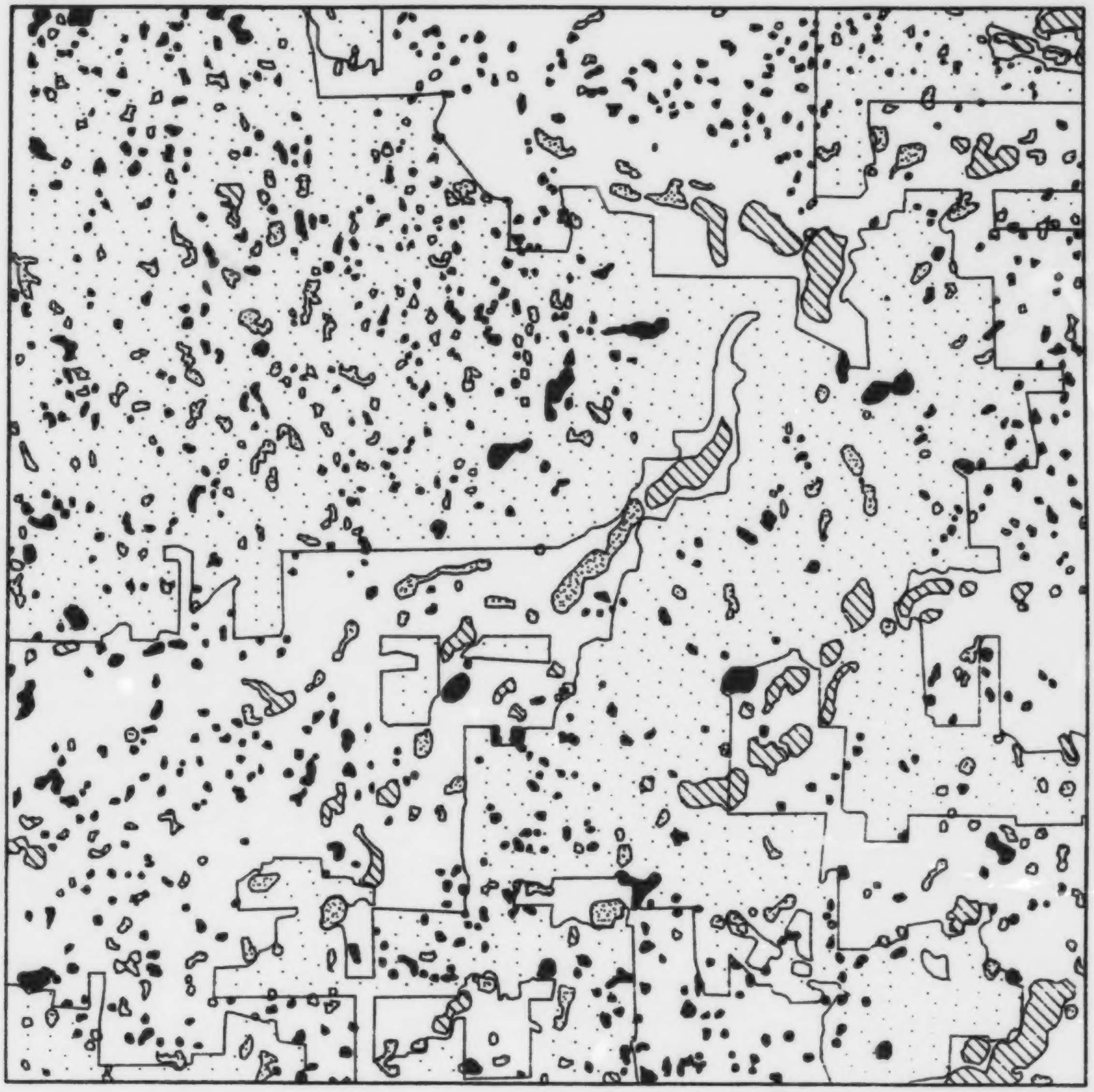
Twp 25 Rge 11

Legend

- ▨ **Temporary and Seasonal Wetlands**
- ▒ **Semipermanent Wetlands**
- ■ **Permanent Wetlands**
- ▧ **Alkaline Wetlands**
- □ **Pasture**
- ⬚ **Agriculture**

Based on Summer 1979 1:56,000 Airphotos
Scale = 1:43,000 (Approx.)

EMA



APPENDIX IV

PRAIRIE POTHOLE STUDY:

ECONOMIC EVALUATION OF WETLAND DRAINAGE AND CULTIVATION

Table V-I

ECONOMIC EVALUATION OF WETLAND DRAINAGE AND CULTIVATION, LOST RIVER STUDY AREA, LOW WETLAND DENSITY, AGRICULTURAL LAND

(1989 Dollars)

	Primary Benefits	Secondary Benefits	Drainage Costs	Land Preparation	Operations/ Maintenance
1990	$0	$0	$17,540	$0	$0
1991	$0	$0	$0	$5,260	$351
1992	$1,414	$4,540	$0	$0	$351
1993	$1,717	$4,540	$0	$0	$351
1994	$2,020	$4,540	$0	$0	$351
to					
2020	$2,020	$4,540	$0	$0	$351

Assumptions:

Farm Size: 1.5 Sections
Area Under Cultivation: 70%
All temporary/seasonal wetlands will be drained.
No financing costs are assumed.

Wetland Characteristics:

	To Be Drained	Total
Wetland Area (ha)	14.2	23.2
Number of Wetlands	20.4	29.2

Economic Evaluation:

BC Ratio	2.14	Internal Rate of Return	22.02%
Discount Rate	10.00	NPV Per Acre	$756
Net Present Value	$26,513	Annualized Benefit/Acre	$72.50

Table V-2

ECONOMIC EVALUATION OF WETLAND DRAINAGE AND CULTIVATION, LOST RIVER STUDY AREA, MEDIUM WETLAND DENSITY, AGRICULTURAL LAND

(1989 Dollars)

	Primary Benefits	Secondary Benefits	Drainage Costs	Land Preparation	Operations/ Maintenance
1990	$0	$0	$23,220	$0	$0
1991	$0	$0	$0	$6,970	$464
1992	$1,869	$6,740	$0	$0	$464
1993	$2,270	$6,740	$0	$0	$464
1994	$2,670	$6,740	$0	$0	$464
to					
2020	$2,670	$6,740	$0	$0	$464

Assumptions:

Farm Size: 1.5 Sections
Area Under Cultivation: 70%
All temporary/seasonal wetlands will be drained.
No financing costs are assumed.

Wetland Characteristics:

	To Be Drained	Total
Wetland Area (ha)	18.8	25.3
Number of Wetlands	35.4	45.4

Economic Evaluation:

BC Ratio	2.32	Internal Rate of Return	23.83%
Discount Rate	10.00	NPV Per Acre	$876
Net Present Value	$40,675	Annualized Benefit/Acre	$84.01

Table V-3

ECONOMIC EVALUATION OF WETLAND DRAINAGE AND CULTIVATION, LOST RIVER STUDY AREA, HIGH WETLAND DENSITY, AGRICULTURAL LAND

(1989 Dollars)

	Primary Benefits	Secondary Benefits	Drainage Costs	Land Preparation	Operations/ Maintenance
1990	$0	$0	$26,920	$0	$0
1991	$0	$0	$0	$8,080	$538
1992	$2,170	$7,300	$0	$0	$538
1993	$2,635	$7,300	$0	$0	$538
1994	$3,100	$7,300	$0	$0	$538
to					
2020	$3,100	$7,300	$0	$0	$538

Assumptions:

Farm Size: 1.5 Sections
Area Under Cultivation: 70%
All temporary/seasonal wetlands will be drained.
No financing costs are assumed.

Wetland Characteristics:

	To Be Drained	Total
Wetland Area (ha)	21.8	44.6
Number of Wetlands	55.6	85.0

Economic Evaluation:

BC Ratio	2.21	Internal Rate of Return	22.74%
Discount Rate	10.00	NPV Per Acre	$803
Net Present Value	$43,238	Annualized Benefit/Acre	$77.01

Table V-4

ECONOMIC EVALUATION OF WETLAND DRAINAGE AND CULTIVATION, KING GEORGE STUDY AREA, LOW WETLAND DENSITY, AGRICULTURAL LAND

(1989 Dollars)

	Primary Benefits	Secondary Benefits	Drainage Costs	Land Preparation	Operations/ Maintenance
1990	$0	$0	$2,590	$0	$0
1991	$0	$0	$0	$780	$52
1992	$189	$1,450	$0	$0	$52
1993	$230	$1,450	$0	$0	$52
1994	$270	$1,450	$0	$0	$52
to					
2020	$270	$1,450	$0	$0	$52

Assumptions:

Farm Size: 1.5 Sections

Area Under Cultivation: 70%

All temporary/seasonal wetlands will be drained.

No financing costs are assumed.

Wetland Characteristics:

	To Be Drained	Total
Wetland Area (ha)	2.1	4.5
Number of Wetlands	3.8	7.0

Economic Evaluation:

BC Ratio	3.82	Internal Rate of Return	37.30%
Discount Rate	10.00%	NPV Per Acre	$1,870
Net Present Value	$9,700	Annualized Benefit/Acre	$179.35

Table V-5

ECONOMIC EVALUATION OF WETLAND DRAINAGE AND CULTIVATION, KING GEORGE STUDY AREA, MEDIUM WETLAND DENSITY, AGRICULTURAL LAND

(1989 Dollars)

	Primary Benefits	Secondary Benefits	Drainage Costs	Land Preparation	Operations/ Maintenance
1990	$0	$0	$19,640	$0	$0
1991	$0	$0	$0	$5,890	$393
1992	$1,470	$4,990	$0	$0	$393
1993	$1,785	$4,990	$0	$0	$393
1994	$2,100	$4,990	$0	$0	$393
to					
2020	$2,100	$4,990	$0	$0	$393

Assumptions:

Farm Size: 1.5 Sections
Area Under Cultivation: 70%
All temporary/seasonal wetlands will be drained.
No financing costs are assumed.

Wetland Characteristics:

	To Be Drained	Total
Wetland Area (ha)	15.9	21.0
Number of Wetlands	23.9	29.2

Economic Evaluation:

BC Ratio	2.07	Internal Rate of Return	21.28%
Discount Rate	10.00%	NPV Per Acre	$707
Net Present Value	$27,775	Annualized Benefit/Acre	$67.83

Table V-6

ECONOMIC EVALUATION OF WETLAND DRAINAGE AND CULTIVATION, KING GEORGE STUDY AREA, HIGH WETLAND DENSITY, AGRICULTURAL LAND

(1989 Dollars)

	Primary Benefits	Secondary Benefits	Drainage Costs	Land Preparation	Operations/ Maintenance
1990	$0	$0	$25,560	$0	$0
1991	$0	$0	$0	$7,670	$511
1992	$1,911	$6,240	$0	$0	$511
1993	$2,321	$6,240	$0	$0	$511
1994	$2,730	$6,240	$0	$0	$511
to					
2020	$2,730	$6,240	$0	$0	$511

Assumptions:

Farm Size: 1.5 Sections
Area Under Cultivation: 70%
All temporary/seasonal wetlands will be drained.
No financing costs are assumed.

Wetland Characteristics:

	To Be Drained	Total
Wetland Area (ha)	20.7	27.3
Number of Wetlands	44.2	48.6

Economic Evaluation:

BC Ratio	2.01	Internal Rate of Return	20.68%
Discount Rate	10.00%	NPV Per Acre	$668
Net Present Value	$34,167	Annualized Benefit/Acre	$64.09

4.5 Net Benefits of Recreation

While the foregoing analysis presents a snapshot of the benefits derived from wetland recreation during one year, these benefits will continue on into the future, assuming that wetland areas are allowed to continue to provide a recreational function. These future benefits can also be counted but, from an economic perspective, some allowance must be made for uncertainty about future recreational preferences and other factors related to demand. To allow for uncertainty, discounting of these future benefits is done using a rate that reflects social preferences in using the resource now rather than at some point in the future. For purposes of this analysis, a discount rate of five percent (net of inflation) has been employed.

If future recreational benefits from wetlands are discounted and aggregated over a 30-year period, the results suggest that the net present value of wetlands in the study area would be at least $3,140 per hectare and the total benefits of wetland recreation over this time period would total $21.7 million (1990 dollars). Of these amounts, benefits to Saskatchewan residents would total $10.3 million, for an average of $1,490 per hectare. Clearly, wetlands can provide significant benefits to Saskatchewan residents if left in their natural state.

1 Environment Canada (1989). Draft Federal Policy on Wetland Conservation and Highlights of Draft Implementation Plan: Discussion Paper, p 5.

2 Ibid.

3 Turner et al. (1987) also reported that 78 percent of wetland margins in Saskatchewan were also affected by agricultural activity during this same period.

4 Examples of these are identified in Stewart and Kontrud, 1971; Zoltai et al., 1975; Millar, 1976; Cowardin et al., 1979; and Canadian Wildlife Service, 1979.

5 Given the size of the study areas (15 townships) and the timing of the study (fall and winter), a methodology which required ground-truthing would not have been feasible.

6 Blue-winged Teal prefer nesting in tall grasses so, for purposes of assessing potential nesting habitat, it was necessary to delineate other habitat types.

7 This conservative estimate was derived from field observations coupled with calculations derived from digitizing all the represented wetland types in the two study areas.

8 For example, Cowan (1981a) listed approximately 45 waterfowl species, 115 other bird species plus a minimum of 50 furbearing and game species such as muskrat, beaver, Ring-necked Pheasants and white-tailed deer that were dependent on wetlands for all or part of their habitat requirements.

9 For example, the Delta Waterfowl and Wetlands Research Station is undertaking ongoing studies which are contributing to the better understanding of ecological processes and are providing applied techniques for resource management.

10 As Ferguson et al. (1989) have correctly identified, wetlands are complex environments and their value does not lie exclusively within a single wetland type but frequently is dependent upon the presence of a diversity of wetlands and associated habitats.

11 Personal communications, A. Didiuk. Estimates are based on unpublished data from the Canadian Wildlife Service for the period from 1970 to 1989. Assumes 1.08 fledged young per adult bird.

12 These estimates assume a hunter success rate of 1.27 ducks per hunter-day, as per data in Metras and Wendt (1986).

13 This observation was made by Jack Knetsch at the "Wetlands Are Not Wastelands" workshop in Ottawa in January of 1990. Due to difficulties in measuring willingness-to-sell values for recreation, the alternative evaluation method based on willingness-to-pay was adopted with the understanding that the resulting values would be at least half of the willingness-to-sell measure of benefit.

14 The Anderson report is a synthesis of the methodology and data contained in two previous studies which examined the nature of secondary benefits from wetland drainage. These two reports include:

Pedology Consultants (1985). Inventory of Alberta's Drainage Requirements - Soils and Agronomy Component - Summary. ISCOD, Edmonton.

Marv Anderson & Associates (1985). Inventory of Alberta's Drainage Requirements - Economics Component - Summary. ISCOD, Edmonton.

15 Adapted from: Visser, P. (1984). A Study of Land Development Costs in the Peace River Region, 1984. Alberta Agriculture.

16 The study is being undertaken by W-E-R Engineering Ltd. on behalf of Alberta Agriculture, Alberta Environment, Alberta Forestry, Lands and Wildlife, Alberta Municipal Affairs and the Alberta Water Resources Commission.

17 Environment Council of Alberta (1989). "New Rural Tax System to Benefit Habitat" in Alberta Conservation Strategy Update. November, 1989.